INSTRUCTION MANUAL

MODEL 9514B CONTROLLER
and
MODEL 9515B OSCILLATOR

Instruction Manual Number 110-951415B

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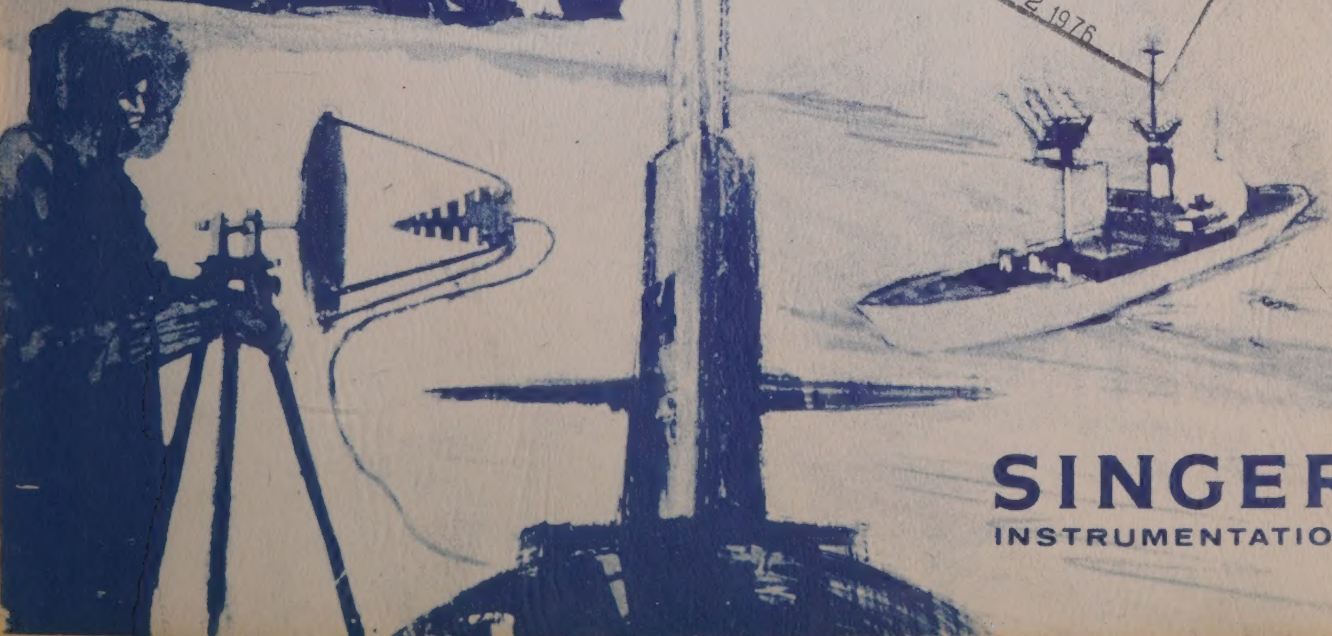

SINGER
INSTRUMENTATION

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Instruction Manual Number 110-951415B

Printed 2/76 Lib

SINGER
INSTRUMENTATION

The Singer Company, Los Angeles Operation • 5340 Alla Road, Los Angeles, Ca. 90066

WARRANTY

THE SINGER COMPANY, LOS ANGELES OPERATION, (SELLER) warrants each new instrument to be free from defects in material and workmanship, effective after delivery to the original purchaser as follows:

TCXO Oscillator ..... 2 Years
Electrical and Electronic Measuring Instruments..... 1 Year

Repair or replacement (at our option) without charge (F.O B. factory) will be effected when our examination satisfactorily indicates that defects are due to workmanship or materials. Electron tubes, semiconductors, batteries, fuses, lamps, thermoelements, and RatioTran potentiometers are excluded from warranty coverage. Warranty returns must first be authorized by the factory.

If the instrument or any portion thereof, has been abused, misused, damaged by accident or negligence, or if any serial number or seal has been removed or altered, the warranty is void.

This warranty is in lieu of all other warranties, express or implied INCLUDING THE IMPLIED WARRANTY OF MERCHANTABILITY, or fitness for a particular purpose. In no event shall the SELLER be liable for INCIDENTAL OR CONSEQUENTIAL damages. The SELLER neither assumes, nor authorizes any person to assume for it, any other liability in connection with sales of instruments manufactured by SELLER.

With respect to repairs, the foregoing warranty shall apply for a period of ninety days to the repaired portion.

THE SINGER COMPANY, LOS ANGELES OPERATION
5340 Alla Road, Los Angeles, California 90066

REPAIR AND MAINTENANCE

Instruments should be returned only on prior authorization from the Singer Representative or the factory. You will be advised of detailed shipping instructions at that time. Return the instrument to the factory Prepaid. Validity of warranty will be determined by the factory.

Chargeable repairs: If requested, an estimate of charges will be made prior to repairs. Please provide us with the following information in order to expedite the processing of your instrument:

1. Model or Type
2. Serial Number
3. Description of trouble(1)
4. Approximate date instrument was placed in operation.
5. Approximate number of hours in use.
6. Has maintenance action been previously requested.
7. Other comments.

(1) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken and any other relevant data.

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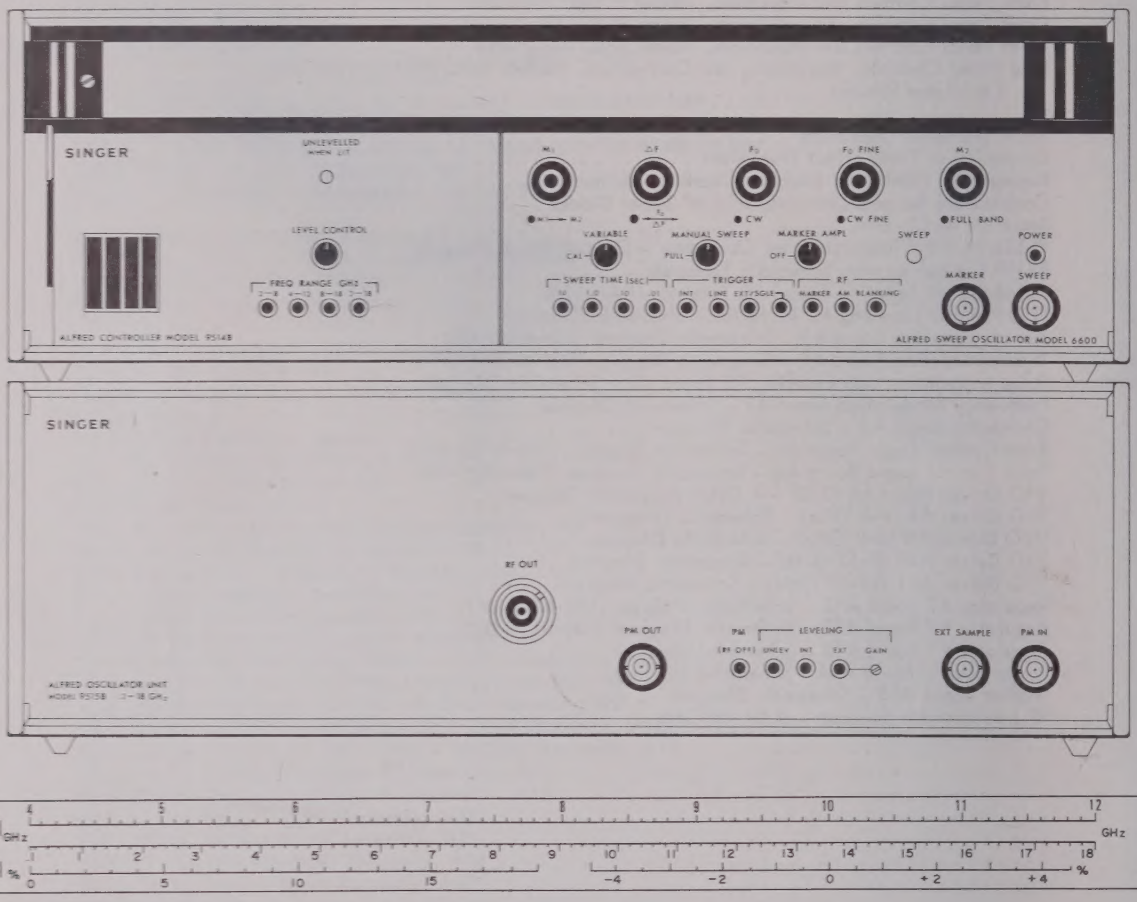
PREFACE

This instruction manual describes the SINGER Model 9514B Controller and the Model 9515B Oscillator; it is intended for use with instruction manual number 110-6020 which describes the SINGER Model 6600 Sweep Oscillator Mainframe. Together, the two manuals provide operating and maintenance instructions for the 6600/9514B/9515B Wideband Swept Oscillator System.



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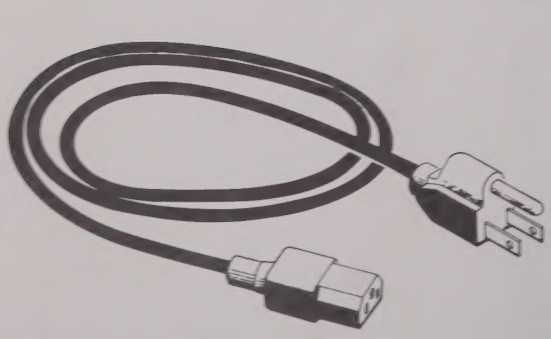
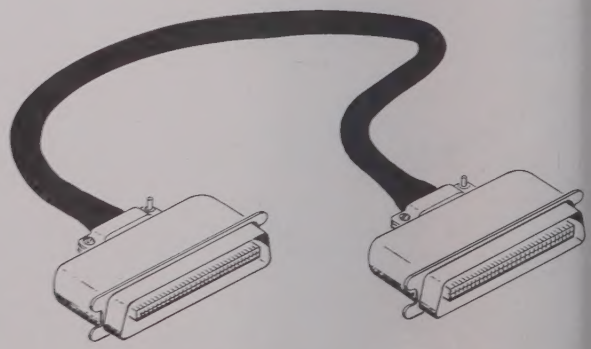


POWER CORD (TYPICAL OF 2)



INTERCONNECT CABLE

Figure 1-1. 6600/9514B/9515B Wideband Swept Oscillator

SECTION I
INTRODUCTION TO YOUR INSTRUMENT

1-1. GENERAL INFORMATION

1-2. Claims for Damage. If the shipping carton is damaged, unpack the instrument in the presence of the carrier or the agent that represents the carrier. If the instrument is damaged, refer to the SHIPMENT DAMAGE CLAIM form included at the rear of this manual for damage-return instructions. If there is no apparent damage but the instrument fails to operate in accordance with procedures and standards provided in Section II, contact your nearest SINGER Sales and Service Representative.

1-3. Repackaging for Shipment. To protect the instrument against the normal hazards of shipping, use the best available methods and packaging materials. Where possible, the original shipping carton and packaging material should be reused for shipment. If the original materials are unavailable or not reusuable, the instrument should be packed as follows:

1. Use a double-walled (preferably wooden) carton that meets the requirements given in Table 1-1.

2. Protect all instrument surfaces with heavy paper, plastic, or sheets of cardboard. Use non-abrasive materials, such as foam rubber or soft cushioning paper, around all projecting parts.

3. Tightly pack at least 4-inches of industry-approved, shock-absorbing material around the top, bottom, and each side of the instrument.

4. Secure the outside of carton with heavy-duty shipping tape; mark "DELICATE INSTRUMENT" on each side of box.

TABLE 1-1. SHIPPING CARTON TEST STRENGTH

Gross Weight (lbs)	Carton Test Strength (lbs)
up to 10	200
10 to 30	275
30 to 120	350
120 to 140	500
140 to 160	600

1-4. Address shipping carton as required; to expedite return of equipment, tag instrument with name of company, name of sender, address, and telephone number.

1-5. Notice of Warranty. This instrument is warranted as specified in the frontis material. To protect the warranty and avoid consequential damages, the operating instructions should be closely followed; also, sealed assemblies and/or other factory adjustments should not be disturbed.

1-6. INSTRUMENT/ASSEMBLY IDENTIFICATION

1-7. An identification plate showing the serial number and the model-or-part number is affixed to the rear of each SINGER instrument. When applicable, option numbers are also shown on the indentification plate or, in some cases, on a separate sticker that is located nearby. All printed circuit cards are indentified with a ten-digit number and, where applicable, a two-digit revision code. Most encapsulated assemblies and microwave modules are also identified by part numbers for quick and easy maintenance. All inquiries regarding operation, calibration/adjustment, and service should be accompanied with the complete serial number and other identifying data.

1-8. INSTRUMENT DESCRIPTION

1-9. Operating Capabilities. When combined with a Model 6600 or a Model 6600A mainframe, the Model 9514 plug-in Controller and Model 9515 Oscillator form a wide-band swept oscillator system (Figure 1-1). The 9514/9515 equipment series covers the range of frequencies from 10 MHz to 18 GHz. This range of frequencies is divided into fifteen discrete bands which are served by the system suffixes shown in Table 1-2. Thus, the 6600/9514/9515 (suffix B) system described in this manual provides the following pushbutton-selected bands: 2-8 GHz, 4-12 GHz, 8-18 GHz, and 2-18 GHz. Any selected band can be continuously swept; both the sweep width and sweep rate can be independently adjusted by the operator. In addition to the swept RF output, the instrument also serves as a single-frequency signal source that is tunable anywhere within its range with accuracy and stability rivaling that of mechanically-tuned signal generators. The controller/oscillator plug-ins are supplied with linearly-calibrated frequency dials; these dials are located in dust-free slots at the front of the mainframe.

TABLE 1-2. FREQUENCY RANGES OF 6600/9514/9515 SYSTEM

FREQUENCY RANGES (GHz)	SYSTEM SUFFIXES												
	A	AS	B	BS	C	CS	D	DS	E	ES	FS	G	GS
.01-.2													
.1-2													
.1-4													
1-2													
1-4													
2-4													
2-8													
4-8													
4-12													
8-12.4													
8-18													
12.4-18													
.1-18													
1-18													
2-18													

1-10. Circuit functions are divided between the mainframe and plug-in assemblies as follows:

1. 6600 or 6600A Mainframe – contains the main power supply, the frequency-control circuits, and the modulator circuits.

2. 9514 Controller – contains both remote and manual band-control logic, and part of the level-control circuits.

3. 9515 Oscillator – contains an auxilliary power supply and all RF components.

1-11. Summary of Operation. Either mainframe provides three sweep mode, three markers, internal/external modulation and leveling capabilities, display outputs, and several other features. There are three electronically controlled automatic sweeps (full band, narrow-band symmetrical, and marker); a manual sweep mode is also provided. The full band sweep covers the full frequency range. During narrow-band symmetrical sweep (ΔF) operation, the frequency can be swept up to ±10% of the full frequency range about any desired center point (F_o). In the marker-sweep mode, two marker frequencies (M1 and M2) are selected; the swept output starts at M1 and ends at M2. Any one of four sweep modes are provided – free running, automatic line triggering, external triggering, and manual triggering. Sweep times from 10-milliseconds to 10-seconds can be selected by the operator; each selected value can be expanded by a factor-of-10 with an associated control, that is, if 10-milliseconds is selected, the control can be adjusted for any sweep time between 10- and-100 milliseconds. During manual sweep, any frequency within the range of the instrument or between preset markers can be selected. Three frequency markers are available in the full-band mode of operation and two markers are available in the ΔF mode of operation. The markers appear as RF pips at the selected frequency. Video markers are also available at the MARKER output connector.

1-12. Several voltages are available for oscilloscope and X-Y recorder control. For X-axis deflection, a 0-to-10 volt ramp that is coincident with the RF sweep is provided; plus-and-minus 10-volt blanking pulses are also provided during retrace. Also during retrace with sweep times greater than 1-second, a relay with isolated contacts can be used to operate a recorder pin lift. At the option of the operator, the RF output can be left on or automatically removed during the retrace time.

1-13. The RF output can be amplitude-modulated by either an external signal or by an internally-generated squarewave. The squarewave frequency is continuously adjustable from 950 to 1050 Hz. Provisions are also provided for external frequency modulation. The RF output can be leveled across all of any swept band.

1-14. System Applications. Besides the swept and fixed tuned frequency capabilities, the 6600/9514B/9515B system provides many modulation and control options; thus, the system meets practically all requirements of microwave signal generation. The instrument is particularly useful for network analysis and any other area that requires precision swept-frequency measurements. Since the system can be amplitude-, frequency-, or pulse-modulated and, computer-programmed as well, a complete range of microwave measurements can be performed.

1-16. Tables 1-3 and 1-4, respectively, provide a tabularized listing of specifications and options pertaining to the 6600/9514B/9515B system.

TABLE 1-3. SPECIFICATIONS OF 9514B CONTROLLER AND 9515B OSCILLATOR WHEN USED IN 6600(A) MAINFRAME

FREQUENCY CHARACTERISTICS (at 25°C)

RANGE: 2-18 GHz in five overlapping, pushbutton-selected bands as follows.

Band 4 ..... 2-8 GHz
Band 5 ..... 4-12 GHz
Band 6 ..... 8-18 GHz
Band 7 ..... 2-18 GHz

ACCURACY: As indicated.

BAND	FREQ RANGE	ACCURACY
4	2-8 GHz	±1%
5	4-12 GHz	±1%
6	8-18 GHz	±1%
7	2-18 GHz	±2%

STABILITY: As indicated.

VARYING PARAMETERS	FREQUENCY IN GHz			
	2-4	4-8	8-12.4	12.4-18
Temperature (25°C Reference)	±300 kHz/°C	±500 kHz[1]/°C	±1 MHz/°C	±3 MHz/°C
±10% Line Voltage	20 kHz	30 kHz	40 kHz	50 kHz
10 dB Power Level	1 MHz	1 MHz	1 MHz	1 MHz
3:1 VSWR	100 kHz	200 kHz[1]	500 kHz	1 MHz

SPECTRAL CHARACTERISTICS

RESIDUAL FM:

2-4 GHz: 10 kHz
4-8 GHz: 15 kHz
8-12.4 GHz: 20 kHz
12.4-18 GHz: 30 kHz

RESIDUAL AM:

-50 dB (200 kHz from carrier with 10 kHz Bandwidth)

HARMONIC RESPONSES:

≤10 GHz: -20 dB (referred to carrier)
>10 GHz: -30 dB (referred to carrier)

NON-HARMONIC RESPONSES:

2-18 GHz: -50 dB (referred to carrier)

OUTPUT CHARACTERISTICS

LEVELED POWER[2] at 25°C: 5 mW from 2-18 GHz

POWER VARIATIONS:

Internally Levelled:

Widest Band: ±1.5 dB
Other Bands: ±0.5 dB (typical)

Externally Leveled: ±0.1 dB (plus any directional detector variations)

Leveled Power Control Range: 10 dB

MODULATION CHARACTERISTICS

INTERNAL AM MODULATION:

Frequency: 1 kHz (±50 Hz) squarewave

[1] 1 MHz with Option 20

[2] Refer to Table 1-4 for output levels of Options 10 and 20

TABLE 1-3. SPECIFICATIONS OF 9514B CONTROLLER AND 9515B OSCILLATOR WHEN USED IN 6600(A) MAINFRAME (CONTINUED)

MODULATION CHARACTERISTICS (Cont'd)

INTERNAL AM MODULATION

Detected RF Output:
Risetime (Leveled): 20 µsec
Risetime (Unleveled): 2 µsec
On/Off Ratio: 45 dB

EXTERNAL AM MODULATION (Internal PIN Modulator):

Input Signal: Pulse or squarewave
Frequency:
Leveled: DC to 3 kHz
Unleveled: DC to 100 kHz
Detected RF Output:
Risetime (Leveled): 20 µsec
Risetime (Unleveled): 2 µsec
Modulation Sensitivity:
Rear-Panel Connector of 6600(A) Mainframe:
0V – Off/1V – On into approximately 200 ohms
Front-Panel Connector of 9515B Oscillator:
0V – Off/1V – On into 50-ohms

EXTERNAL AM MODULATION (External PIN Modulator):

Input Signal: Pulse or squarewave at front-panel connector of 9515B oscillator
Frequency (Leveled or Unleveled): DC to 1 MHz
Input Impedance: 50-ohms
Minimum Pulse Width: 50 nsec
Detected RF Output (Leveled or Unleveled):
Approximately 15 nsec (depending on characteristics of PIN switch)
Sensitivity: 0V – Off/2V – On into 50-ohms
On/Off Ratio: Typically 20 dB at 100 MHz; 45 dB at 18 GHz (depending on characteristics of PIN switch)

EXTERNAL FM MODULATION (Rear-Panel of 6600 Mainframe):

Deviation: 0 to 100% of fullband
Modulation Rate: DC to 100 Hz for fullband sweep – increasing for reduced deviations

EXTERNAL FM MODULATION OR PHASE LOCK (Rear-Panel of 9515B Oscillator):

Modulation Rates:
DC-1 kHz: ±60 MHz maximum peak deviation (maximum input ±10V)
DC-100 kHz (-3 dB): ±1.2 MHz maximum peak deviation (maximum ±0.2V)
FM Sensitivity:
Approximately 6 MHz/Volt

GENERAL CHARACTERISTICS

RAMP OUTPUT SIGNALS:

Sweep Ramp (Front-Panel of 6600 Mainframe):
0-10 volts independent of sweep width
Vpf (Voltage Proportional to Frequency at Rear-Panel of 6600 Mainframe): 0-10 volts proportional to start and stop frequencies
Vpf (Rear-Panel of 9515B Oscillator):
2-18 GHz: 1V (±2% + 40 mV) per GHz

DIMENSIONS:

Height: 10 1/2 inches
Width: 16 3/4 inches
Depth: (Behind Panel): 16 3/4 inches
Weight: Approximately 78 pounds

INPUT POWER: 115V (±10%) or 230V (±10%); 50/60 Hz, approximately 215 Watts.

TABLE 1-4. 9514B/9515B OPTIONS

Option No.	Description/Applicability
1	Side panel carrying handle (Option 2 for 6600 mainframe)
2	Operation from 380-420 Hz power source (Option 3 for 6600 mainframe)
5	Remote digital programming, TTL compatible (6600 only): Enable . . . . . 1-line binary Band Selection . . . . . 4-line binary Frequency Select . . 12-line binary 1000 discrete frequencies Enable Internal Squarewave . . . . . 1-line binary
6	Rack-mount kit for 6600(A) mainframe
10	Leveled output power of 10 mW
12	Rack-mount kit for 9515B oscillator
20	Leveled output power of 20 mV

10

SECTION II
OPERATION

RECEIVING INSPECTION

Upon receiving your Model 9514B/9515B, carefully ack the instruments and check for shipment damage. If age is evident, file a claim against the carrier. Refer he Shipment Damage Claim form in the back of this ual.

Check the unit for shipping damage. The front el controls should move easily, with full travel and tive detents. Note any mechanical damage, and check condition of accessories shipped with the unit. If there ny damage or deficiency, or if electrical performance is within specifications, see the warranty inside the front er of this manual.

Inspect the units for humidity and heat damage r any long storage period. Minimum performance tests uld be made after each of these inspections (paragraph 4). No attempt should be made to make any repairs to plug-in unit or to make adjustments without complete iliarization with the information contained in Section IV.

5. PRELIMINARY INSPECTIONS

Preliminary inspection of the equipment is performed hout operating power applied. This type of check is de- ed to detect conditions that might otherwise lead to a akdown. Frequent causes of premature failure are over- ting, due to improper ventilation or accumulation of dust dirt, and/or loose connections and fittings. Inspection carried out with emphasis on finding evidence of these nditions. Table 2-1 lists the preliminary inspection cks for the equipment.

7. POWER REQUIREMENTS

The 9514B operates when it is plugged into a 6600 inframe; power is supplied by the 6600. The 9515B uses 5V or 230 VAC.

The unit is normally connected at the factory for eration at 105 to 125 VAC (115 VAC nominal) and 50 to Hz. To convert to 230 VAC (nominal) line power, re- ve the line power cord from the rear panel receptacle, slide the plastic protective cover to expose the fuse. move the fuse, and slide the switch (with the arrow) to the 0V position. Insert a new fuse.

NOTE

For 115 VAC, use a 3 A slow-blow fuse.
For 230 VAC, use a 1.5 A slow-blow fuse.

de the plastic cover back, and replace the line power cord the receptacle. To reconvert to 115 VAC operation, re- rse the above procedure.

-10. CHASSIS GROUNDING

11. The chassis has a three-conductor power cord and a ee-prong plug, which grounds the instrument when plugged into an appropriate receptacle. If a three-prong or two-prong adapter is used, ground the chassis by connecting the adapter pigtail lead to a suitable ground.

WARNING

Failure to ground the instrument properly can degrade its performance and stability, and could permit an above-ground potential on the chassis, which could be dangerous to operating personnel.

2-12. COOLING

2-13. Adequate space must be provided at the top, rear, and bottom of the 9515B for cooling purposes. Although forced air cooling is provided, space for flow of the cooling air is required. Allow one inch at the rear and top and one-half inch at the bottom.

2-14. REMOVING AND INSTALLING THE 9514B CONTROLLER

2-15. Removing the 9514B:

1. Disconnect cable assembly.

2. Pull lock lever at front left side of 6600 down. The 9514B will then move out about an inch.

3. Remove 9514B.

2-16. Installing the 9514B:

1. Insert the 9514B through the front panel opening and push it into place.

2. Push lock lever up.

2-17. FREQUENCY DIAL INSTALLATION

2-18. The Frequency Dial is installed as follows:

1. Select the frequency scale corresponding to the range of the 9515B.

2. Place the beveled edge at the left end of the frequency scale under the lip at the left end of the Model 6600 frequency dial.

3. The corresponding lip at the right end of the Model 6600 frequency dial is spring-loaded. Slide it about 1/4 inch to the right, and place the frequency scale in position over the frequency dial.

4. Release the sliding lip and check to be sure that the scale is secure. Calibrate dial as indicated in the next paragraph.

TABLE 2-1. PRELIMINARY INSPECTION CHECKS

ITEM	INSPECT FOR	CORRECTIVE ACTION
Connectors	Looseness, bent or corroded contacts, signs or arcing	Clean contacts with cloth moistened with cleaning solvent trichloroethylene or equivalent. Replace connectors if damaged or deeply corroded.
Mainframe and Front Panel	Dirt and corrosion	Clean with cloth moistened with cleaning solvent trichloroethylene or equivalent.
Knobs, screws, connectors, clamps	Looseness	Tighten using appropriate torque so as not to strip threads.
Switches	Looseness	Tighten mounting screws or nut.
Wiring	Looseness	Resolder, recable, or reclamp.
Solder joints	Loose or cold solder connections; corrosion	Clean carefully and resolder, using recommended soldering iron.
Printed circuit boards	Mounting looseness	Replace mating plug if required.
	Loose components	Resolder loose components.
Resistors	Cracks, chipping, blistering, discoloration, and other signs of overheating	Replace resistor.
Capacitors	Leaks, bulges, signs of aging	Replace capacitor.
	Loose mounting bracket	Tighten nuts or screws holding bracket.
Switch contact	Dirt, dust, and/or corrosion	Clean with cloth, aerosol spray, Syringe or camel-hair brush using trichloroethylene or equivalent.
	Bent or broken contacts	Replace switch wafer or assembly.
Transistors	Looseness	Seat firmly in sockets, or resolder leads to etched circuit.

2-19. FREQUENCY DIAL POSITION CALIBRATION

2-20. Calibrate the Frequency Dial position as follows:

1. To the left of the dial is a conventional flathead screw.

2. On the left end of the dial there is a calibration line.

3. There are corresponding calibration dots behind the dial.

4. Use the flathead screw to line up the calibration marks.

2-21. CONTROLS, INDICATORS, AND CONNECTORS

2-22. Front panel controls, indicators, and connectors of the 9514B controller, the 9515B oscillator, and the 6600 are shown and described, respectively, in Figure 2-1/Table 2-2, Figure 2-2/Table 2-3, and Figure 2-3/Table 2-4. All controls, indicators, and connectors located on the rear panel are shown and described, respectively, in Figure 2-4 and Table 2-5.

2-23. OPERATING INSTRUCTIONS FOR THE 9514B/9515B SYSTEM

2-24. Turn-On Procedure.

1. Plug the 9514B into the 6600 mainframe. Connect the 9515B to the 9514B with the Interconnect Cable.

2. Ensure that the rear panel 115/230 volt switches are set for the correct line voltage. Check also for the correct fuse rating (see paragraph 2-9). Plug the 6600 and 9515B line power cords into AC outlets.

3. Press POWER pushbutton on the 6600 to apply power and ensure that the blower fans are operating.

4. Allow the equipment to warm up for at least 15 minutes.

-25. Sweep Frequency Operation.

-26. There are three recurring sweep modes: Full Band, Marker Sweep, and ΔF Narrow Band Sweep.

-27. Full Band Sweep. In Full Band sweep mode, the nit sweeps across the entire frequency range selected by the 514B controller. The sweep is in the direction of increasing requency with all markers (M1, M2 and F_o) present at the F output of the 9515B. Full Band sweep is convenient for uick testing over an entire band. For Full Band sweep, set he controls as follows:

1. Press FULL BAND pushbutton.

2. If RF output is to be off during sweep retrace, press F BLANKING pushbutton.

3. Select desired sweep-time range and press the corres-onding SWEEP TIME (SEC) pushbutton. Set VARIABLE sweep ime control to CALibrate position for sweep time that is xactly equal to pushbutton-selected time. If the VARIABLE ontrol is turned fully clockwise, the switch-selected value an be expanded by a factor-of-10.

4. Press the desired TRIGGER mode pushbutton.

5. Push the MARKER pushbutton to enable RF marker eneration. Read marker positions at appropriate scale of requency dial. Adjust marker amplitude using the MARKER MPL control. Video markers are not controlled by the MARKER pushbutton.

-28. Marker Sweep. Marker sweep mode is similar to he Full Band sweep mode, but is convenient for testing over arrower portions of the band. The Marker Sweep start and top points can be set anywhere within the band for either a requency upsweep or downsweep. The sweep always starts t M1, and stops at M2. To operate the Marker Sweep (bracket the sweep about any portion of the band), proceed s follows:

1. Using M1 and M2 controls, set markers (read at top scale of frequency dial) to the desired sweep start and stop points. For downsweep, set M1 above the frequency of M2.

2. Depress M1 → M2 pushbutton to enable the Marker Sweep mode.

3. Set the sweep time, blanking, etc., controls for convenience, as in Full Band sweep. Note that only the F_o marker operates in Marker sweep mode.

4. Activate RF marker generation by pressing the RF MARKER pushbutton. Adjust the marker amplitude with the MARKER AMPL control.

5. To disable F_o marker generation, turn MARKER AMPL control to OFF, or press RF MARKER pushbutton off to disable RF marker only.

2-29. Δ F NARROW BAND SWEEP

2-30. The ΔF sweep is a narrow-band sweep that is symmetrical about the F_o center frequency. The ΔF sweep extends from $-\Delta F/2$ to $+\Delta F/2$ about F_o as read on the ΔF scale. Maximum sweep width is 20% of the full band. The F_o and ΔF controls operate independently of one another and can be reset during narrow-band operation to obtain the desired F_o center frequency. To operate in ΔF mode, proceed as follows:

1. Press $\overset{F_o}{\underset{\Delta F}{\leftrightarrow}}$ pushbutton to place unit in narrow-band sweep mode.

2. Adjust ΔF control to the desired narrow-band sweep width, as read on the ΔF scale.

3. To center fixed ΔF window (narrow-band-sweep to any frequency, tune the F_o control to the frequency of interest.

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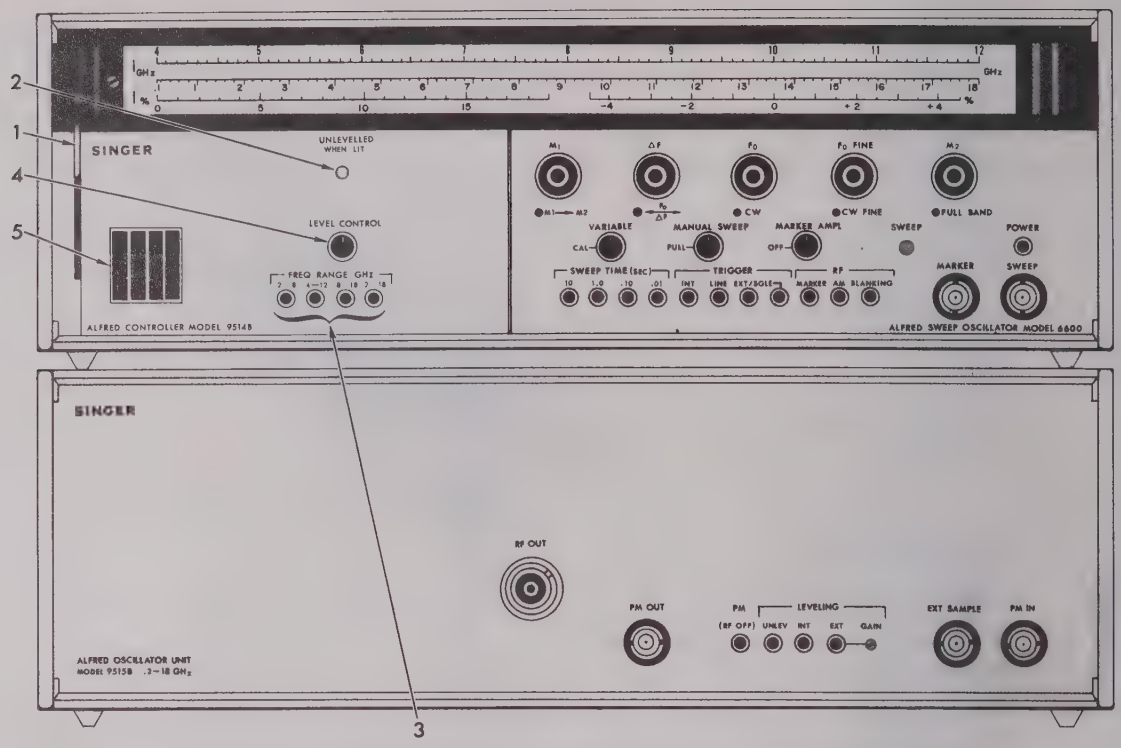

Figure 2-1. Front Panel Controls and Indicators, Model 9514B Controller

TABLE 2-2. FRONT PANEL CONTROL/INDICATOR FUNCTIONS OF 9514B CONTROLLER

KEY	NAME	FUNCTION
1	Release/Locking Lever	When pulled outward, release the 9514B plug-in. With plugin installed and pushed all the way forward, the lever is pushed in (towards mainframe) to secure plugin.
2	UNLEVELED WHEN LIT indicator	When lighted, indicates that signal at RF OUTput connector (1, Figure 2-2) is unleveled. (NOTE: During leveled operation, indicator will light if sampler drive is insufficient – refer to LEVEL CONTROL.)
		When indicator is not lighted, indicates that RF output signal is leveled.
3	FREQ RANGE GHz	
	2-8 Pushbutton	When pressed, selects swept frequency output over the 2-8 GHz band at RF OUT connector (Figure 2-2). If 2-8 pushbuttons is pressed and CW mode is also selected, the operator can manually tune any fixed frequency within the band.
	4-12 Pushbutton	Except for frequency differences, same function as 2-8 GHz pushbutton.
	8-18 Pushbutton	Except for frequency differences, same function as 2-8 GHz pushbutton.
	2-18 Pushbutton	Except for frequency differences, same function as 2-8 GHz pushbutton.

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TABLE 2-2. FRONT PANEL CONTROL/INDICATOR FUNCTIONS OF 9514B CONTROLLER (CONT'D)

KEY	NAME	FUNCTION
4	LEVEL CONTROL	Controls the output power level at RF OUT connector (1, Figure 2-2). When set to the 3 o'clock position, maximum leveled power is available. When set to the 9 o'clock position, the maximum leveled power is reduced by nominally 10 dBm. From stop-to-stop, the control provides a nominal range of 16 dBm. (NOTE: If, during leveled operation the UNLEVELED WHEN LIT indicator lights, move LEVEL CONTROL slightly counterclockwise.)
5	FREQUENCY DIAL SLOTS	As shipped, a frequency dial is included in three of the four slots – refer to paragraphs 2-17 through 2-20 for installation/calibration procedures.

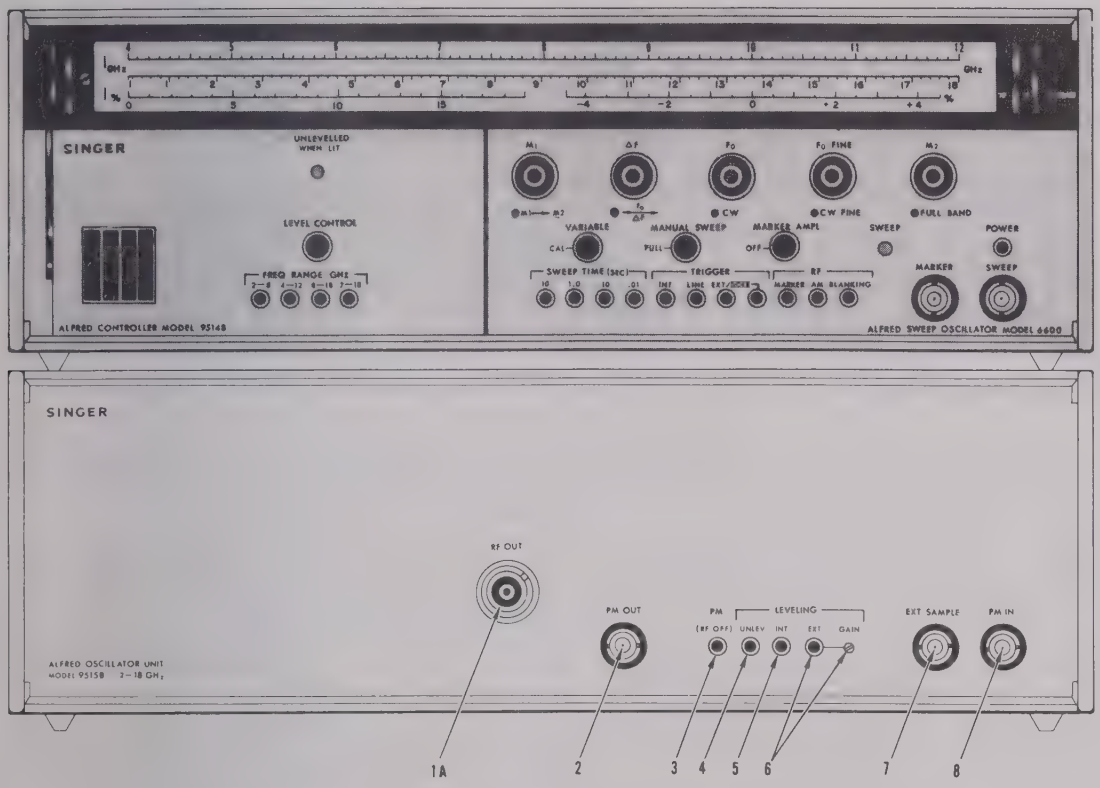

Figure 2-2. Front Panel Controls and Indicators, Model 9515B Oscillator

TABLE 2-3. FRONT PANEL CONTROL/INDICATOR FUNCTIONS OF 9515B OSCILLATOR

KEY	NAME	FUNCTION
1A	RF OUT Connector #1: 0.01-0.2 GHz (BNC female)	Provide swept or CW RF output signal. Frequencies, amplitude, and marker positions are determined by control settings on the 9514B controller and the 6600 mainframe.
2	PM OUT Connector	Provides no function, unless INT/EXT switch on printed-circuit card A3 is set to EXT – as shipped from factory, the switch is set to INT. If the INT/EXT switch is set to EXT, the RF output is externally pulse modulated in the following manner.

TABLE 2-3. FRONT PANEL CONTROL/INDICATOR FUNCTIONS OF 9515B OSCILLATOR (CONT'D)

KEY	NAME	FUNCTION
2	PM OUT Connector (Cont'd)	If an external modulating signal (nominally a 1-volt pulse) is connected to the PM IN connector (9) and the PM (RF OFF) pushbutton (3) is pressed, the PM OUT connector provides a pulse-modulating signal to an external PIN modulator that is connected to RF OUT connector (1). (NOTE: Depending on the type of external modulator, other changes on printed circuit card A3 may be required – refer to schematic notes to make this determination. If no signal is applied to the PM IN connector and the PM (RF OFF) pushbutton is pressed, the RF output signal is switched off.
3	PM (RF OFF) Pushbutton	When pressed, turns RF off and enables external modulation capability – refer to preceding description of PM OUT connector.
4	LEVELING UNLEV Pushbutton	When pressed, disables internal or external sampler and makes the RF output level dependent upon the setting of the LEVEL CONTROL (4, Figure 2-1).
5	LEVELING INT Pushbutton	When pressed, enables internal sampler and leveling loop.
6	LEVELING EXT Pushbutton and GAIN Control	When an external sampler is connected to EXT SAMPL connector (7) and EXTernal pushbutton is pressed, a leveled RF output is obtained from an external sampler. The GAIN control is adjusted to provide an optimum RF input to the external detector. (NOTE: To minimize losses, particularly high-frequency losses, special low-loss cables should be used to connect the RF OUTput (1) to the external sampler.)
7	EXT SAMPL Connector	When connected to output of external detector, provides external control over leveled RF output – refer to preceding item.
8	PM IN Connector	When connected to external pulse source (minimum 1-volt amplitude) and PM (RF OFF) pushbutton is pressed, RF output is pulse modulated – refer to items 2 and 3.

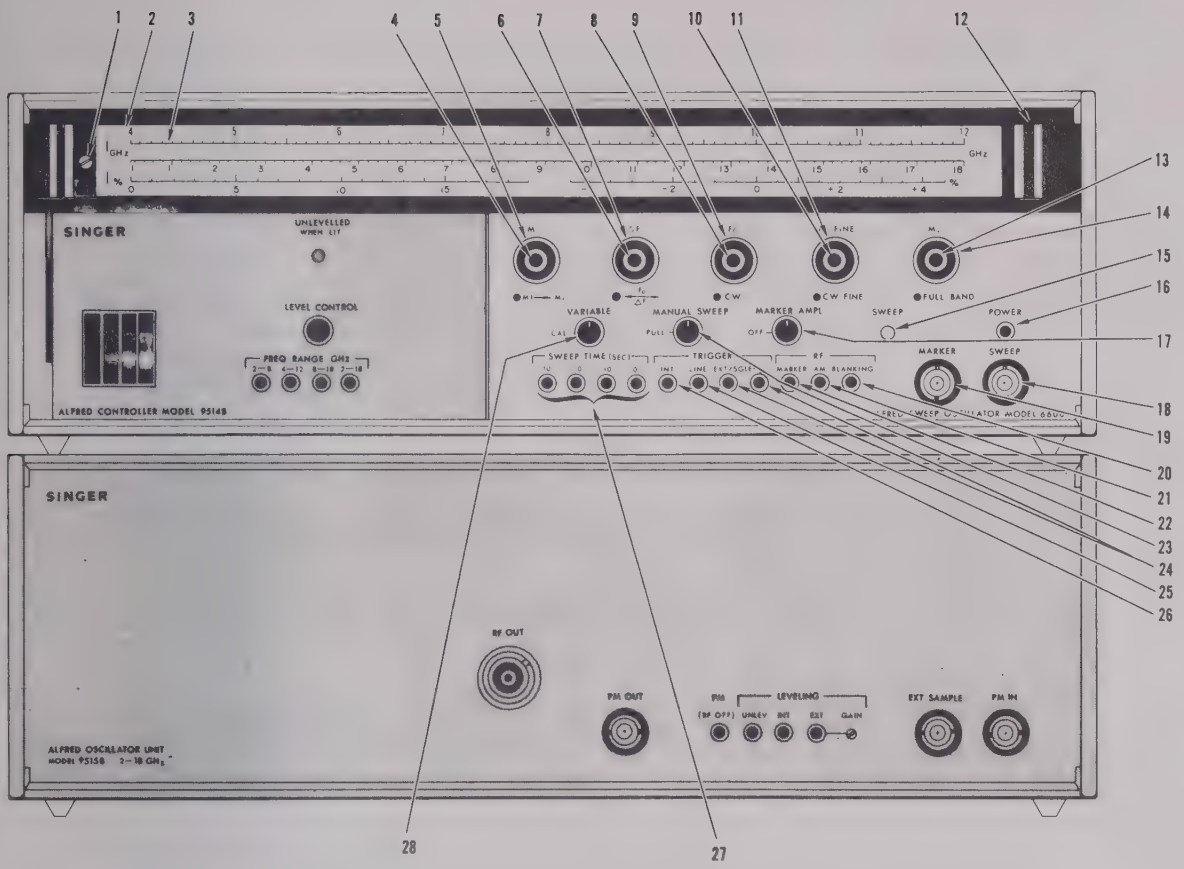

Figure 2-3. Front Panel Controls and Indicators, Model 6600 Mainframe

TABLE 2-4. FRONT PANEL CONTROL/INDICATOR FUNCTIONS OF 6600 SWEEP OSCILLATOR MAINFRAME

KEY	NAME	FUNCTION
1	DIAL Calibration Screw	When turned clockwise, moves frequency dial (3) to right; counterclockwise rotation of screw moves dial to the left. Screw is properly adjusted and dial is calibrated when bar (2) is aligned with two dots on dial tape.
2	Calibration Bar and Alignment Dots	Refer to item 1.
3	Frequency Dial	Three dials are required to cover all tunable frequency ranges of the instrument. Each dial is divided into four calibrated scales – the upper scale specifies the applicable pushbutton range. For the 5514B, the upper scale of the three dials are respectively, calibrated as follows: 2-8 GHz, 4-12 GHz, and 8-18 GHz. The middle scale of each dial covers the entire frequency range (2-18 GHz). The lower scale of each dial is split into two sections, the one to the left pertaining to ΔF and the other calibrated F_o-FINE. The ΔF and F_o-FINE scales are calibrated in percent of full band.
4	M1 → M2 Pushbutton	When pressed, enables the marker-sweep mode of operation. The two marker frequencies are set by the M1 and M2 controls (5 and 14).
5	M1 Control	Moves the M1 marker from one end of the frequency scale to the other. (NOTE: If 2-18 pushbutton on the controller is pressed, the M1 frequency is read from the middle scale, that is, the lower pip on the marker symbol. If the 4-12 pushbutton is pressed, the marker frequency is read from the upper scale. To avoid readout errors,

TABLE 2-4. FRONT PANEL CONTROL INDICATOR FUNCTIONS OF 6600 SWEEP OSCILLATOR MAINFRAME (CONT'D)

KEY	NAME	FUNCTION
5	M1 Control (Cont'd)	make certain that both low-and-high limits on upper scale of dial agree with range selected at controller; if full-band sweep is selected, the center scale of all dials can be accurately read.)
6	$\frac{F_o}{\Delta F}$ Pushbutton	When pressed, enables the delta-F mode of operation; refer to ΔF and F_o controls (7 and 9).
7	ΔF Control	Moves ΔF marker from 0% to 20% on left hand section of lower scale. In the ΔF mode, the center frequency (F_o) selected by the F_o control (9) is symmetrically swept. The deviation about F_o is determined by the frequency range selected at the controller and the setting of ΔF. For instance, if 4-12 GHz is selected at the controller, the full-band range is 8 GHz (12-4=8). Assuming ΔF is set to 10 (±5% symmetrical sweep), the sweep range is 400 MHz (±5% of 8 GHz = ±400 MHz). Accordingly, the frequency selected by F_o is continuously swept through an 800 MHz window – 400 MHz below F_o to 400 MHz above F_o. If the full-band range is increased or, if ΔF-percent is increased for a given range, the swept window is widened, whereas, if either the full-range or ΔF is decreased, the swept window is narrowed.
8	CW Pushbutton	When pressed, disables the swept mode and enables the CW (continuous wave) mode of operation. In this mode, any frequency within the selected range can be manually tuned by F_o (9).
9	F_o Control	Moves the F_o marker from one end of frequency scale to the other. (NOTE: If 0.1-18 pushbutton on the controller is pressed, the F_o frequency is read from the middle scale, that is, the lower pip on the F_o symbol. If the 4-12 pushbutton is pressed, the F_o frequency is read from the upper scale. To avoid readout errors, make certain that both low-and-high limits on upper scale of frequency dial agree with the range selected at the controller; if full-band sweep is selected, the center scale of all frequency dials can be accurately read.
10	CW FINE Pushbutton	When pressed, disables CW mode and enables CW-Fine mode. In this mode, the F_o FINE control is really an extension of the F_o control, that is, it is a vernier frequency adjustment, whereas, F_o provides a coarse adjustment. A calibrated frequency deviation of as little as ±0.5% or as much as ±5% of F_o can be achieved with F_o FINE.
11	F_o FINE Tuning Control	Moves F_o FINE marker from limit-to-limit on right hand section of lower scale. In the CW-fine mode, the F_o-FINE control is really an extension of the F_o control, that is, it is a vernier frequency adjustment, whereas, F_o provides a coarse adjustment. A calibrated frequency deviation of as little as ±0.5% or as much as ±5% of F_o can be achieved with F_o FINE.
12	Dial Release Slide	When pulled towards end of instrument, releases frequency dial for removal.
13	FULL BAND Pushbutton	When pressed, enables full-band sweep and provides a swept output from 2-18 GHz at RF OUTput connector (1, Figure 2-2).
14	M2 Control	Moves the M2 marker from one end of frequency scale to the other. (NOTE: If 2-18 pushbutton on the controller is pressed, the M2 frequency is read from the middle scale, that is, the bottom pip on the marker symbol. If the 4-12 pushbutton is pressed, the marker frequency is read from the upper scale. To avoid readout errors, make certain that both low-and-high frequency limits on upper scale of frequency dial agree with the range selected at controller; if full-band sweep is selected, the center scale of all dials can be accurately read.
15	SWEEP Indicator	Lights during sweep time in both internal and external sweep modes. During manual sweep, cw operation, and retrace, indicator lamp is extinguished.
16	POWER Pushbutton	Press to apply line power to instrument; press again to remove power.

TABLE 2-4. FRONT PANEL CONTROL/INDICATOR FUNCTIONS OF 6600 SWEEP OSCILLATOR MAINFRAME (CONT'D)

KEY	NAME	FUNCTION
17	MARKER AMPL Control	Operates in conjunction with RF MARKER pushbutton (22) to produce video pips in the RF output signal; the marker pulses are also delivered to the MARKER output connector (19). Marker amplitude is adjustable from approximately -6 volts maximum (MARKER AMPL control fully clockwise) to 0-volts when control is set to OFF. For further detail of marker operation, refer to items 19 and 22.
18	SWEEP Connector	Provides a 0 to +10 volt sawtooth output voltage synchronized with RF output frequency. In CW mode, voltage varies from 0 to +10 volts in proportion to F_o and F_o FINE frequency settings.
19	MARKER Connector	Provides output markers of -6 volt amplitude when MARKER AMPL control (17) is turned fully clockwise. (NOTE: To marker-modulate RF output, the RF MARKER pushbutton must be pressed.)
20	RF BLANKING Pushbutton	When pressed, removes RF output during sweep retrace.
21	RF AM Pushbutton	When pressed, RF output is amplitude modulated with an internally generated 1 kHz squarewave, provided rear-panel AM MODE switch is set to INT SQ WAVE. If mode switch is not set to the internal position, the RF output is pulse modulated by an external signal – refer to Figure 2-4/Table 2-5.
22	RF MARKER Pushbutton	When pressed, enables circuits that amplitude modulate the RF output with triangular pips (markers). The amplitude of these triangular pips can be varied by means of the MARKER control. In the marker-sweep ($M_1 \rightarrow M_2$) mode, one marker is provided at F_o. In the fullband mode, three markers are provided at M_1, M_2, and F_o. In the ΔF mode, two markers, M_1 and M_2 are provided. (NOTE: Video markers are always available at the MARKER connector; that is, this output is independent of the MARKER pushbutton.)
23	MANUAL SWEEP Control	When pulled out and turned clockwise, disables all other sweep-trigger modes (24, 25, and 26) and provides manual sweep over frequency limits established by sweep-mode pushbuttons (4, 6, and 13). To enable other sweep-trigger modes (24, 25, and 26), the manual control must be pushed in.
24	TRIGGER EXT/SINGLE Pushbuttons	When the EXTernal pushbutton is pressed, the sweep is triggered in one of two ways. When a trigger source is connected to the rear-panel TRIG IN connector (Figure 2-4/Table 2-5), the sweep is initiated by the external trigger; in this mode of operation, the SINGLE pushbutton functions only as a reset device, that is, if pressed during the swept interval, the sweep resets to zero and starts again. If the EXT pushbutton is pressed and no external trigger is connected, the SINGLE pushbutton when pressed, initiates sweep and, if pressed again before the swept interval is completed, provides a reset function. In either the external-trigger or single-sweep modes of operation, the sweep time is determined by the sweep-time pushbuttons and the associated variable control (27 and 28).
25	TRIGGER LINE Pushbutton	When pressed, sweep rate is synchronized at power-line frequency.
26	TRIGGER INT Pushbutton	When pressed, enables free-running, continually recurring sweep that is triggered upon completion of the preceding sweep.
27	SWEEP TIME (SEC) Pushbuttons	Select on of four sweep ranges whose sweep time is continuously adjustable by VARIABLE vernier control (28) for overall sweep time tuning from 10 msec up to 100 seconds.
	0.01	When pressed, enables continuously variable sweep time from 10 msec to 100 msec.

TABLE 2-4. FRONT PANEL CONTROL/INDICATOR FUNCTIONS OF 6600 SWEEP OSCILLATOR MAINFRAME (CONT'D)

KEY	NAME	FUNCTION
27	SWEEP TIME (SEC) Pushbuttons (Cont'd)	
	0.10	When pressed, enables continuously variable sweep time from 100 msec to 1 second.
	1.0	When pressed, enables continuously variable sweep time from 1 to 10 seconds.
	10	When pressed, enables continuously variable sweep time from 10 to 100 seconds.
28	VARIABLE Sweep-Time Control	When turned fully clockwise, expands each selected sweep time by a factor-of-10, that is, if 0.01 pushbutton (27) is pressed, the sweep time can be varied from 10-milliseconds (CAL position of control) to 100-milliseconds when the control is turned fully clockwise. If the 0.10 pushbutton is pressed, the sweep-time range is from 100-milliseconds to 1-second, and so on for other selections.

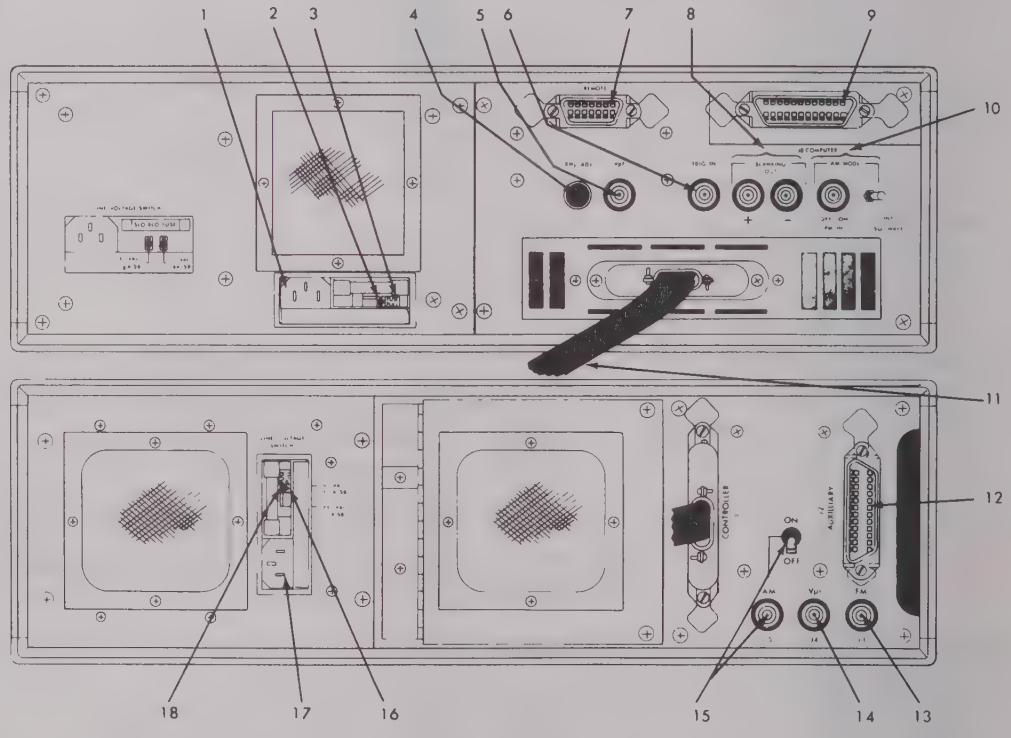

Figure 2-4. Rear Panel Controls, Indicators, and Connectors, Models 9514B/9515B/6600 Swept Oscillator System

TABLE 2-5. REAR PANEL CONTROL/INDICATOR/CONNECTOR FUNCTIONS OF 9514B/9515B/6600 SWEPT OSCILLATOR SYSTEM

Key	Name	Function
1	Input Power Receptacle	When connected to appropriate power source, supplies AC power to 6600 mainframe and 9514B plug-in controller.
2	Line Voltage Switch	When arrow is set opposite 115 VAC as shown in offset view of LINE VOLTAGE SWITCH, the power circuits are automatically programmed for operation from a 115V/60 Hz source – 1.6A Slo-Blo fuse.

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TABLE 2-5. REAR PANEL CONTROL/INDICATOR/CONNECTOR FUNCTIONS OF 9514B/9515B/6600 SWEPT OSCILLATOR SYSTEM (CONT'D)

KEY	NAME	FUNCTION
2	Line Voltage Switch (Cont'd)	When arrow is set opposite 230 VAC, the power circuits require a 230V/50 Hz source and a 0.8A Slo-Blo fuse.
3	Fuse and Fuse-Release Lever	When FUSE PULL lever is moved outward, one end of fuse is removed from holder – replace fuse in accordance with position of line voltage switch (2).
4	1 kHz ADJ Control	Controls frequency of internal 1 kHz square wave generator. Adjusts output between 950 and 1050 Hz in internal AM mode.
5	VpF Connector	Output connector for dc coupled VpF (voltage-proportional-to-frequency) varying from 0 to +10 volts across full band.
6	TRIG IN Connector	When connected to an appropriate trigger source, provides external triggering of sweep if TRIGGER EXT pushbutton (24, Figure 2-3) is pressed and MANUAL sweep control (17, Figure 2-3) is pushed in (off).
7	J1 REMOTE Connector	Provides a means of remotely controlling certain operational functions. Remoted functions can, depending on programming, override front panel control.
8	BLANKING OUTput Connectors	Output connectors for +10 volts and -10 volt blanking pulses for oscilloscope blanking. Blanking occurs during dwell and retrace periods. Front panel RF BLANKING pushbutton does not affect this output.
9	J8 COMPUTER Connector	Provides a means of controlling by digital computer most operational functions. When properly programmed the computer overrides front panel controls and remotely controlled functions of J1. (NOTE: This input is provided with Option 5.)
10	AM MODE Switch and Connector	When switch is set to INT SQ WAVE, RF output is AM-modulated with an internally-generated 1 kHz squarewave, provided the RF AM pushbutton (23, Figure 2-3) is pressed. (Refer to item 4 for frequency control of squarewave.) When switch is set to external (toggle to left) and a pulse or squarewave signal is applied to OFF/ON PM IN connector, the RF output is pulse modulated. (NOTE: To turn RF on, the positive excursion of signal should be between +4.5 and +5 volts – it must not exceed 5 volts. RF is turned off by 0 volts or by a ground source that is capable of sinking 5-milliamperes of current).
11	Interconnecting Cable	Routes dc-control signals between mainframe and 9515FS oscillator.
12	J2 AUXILLIARY Connector	Provides a means of remotely controlling most operating functions of the 9515B oscillator.
13	FM Connector J3	When an appropriate signal is connected, the RF output is FM modulated in all modes of operation. Nominally, a ±10 volt input produces a ±40 MHz deviation around F_o.
14	VpF Connector J4	Provides a 1 volt-per-GHz output in 2-18 GHz range, 10V/GHz in 0.1-2 GHz range and 100 V/GHz in 0.01-0.2 GHz range.

TABLE 2-5. REAR PANEL CONTROL/INDICATOR/CONNECTOR FUNCTIONS OF 9514B/9515B/6600 SWEPT OSCILLATOR SYSTEM (CONT'D)

KEY	NAME	FUNCTION
15	Line Voltage Switch	When arrow is set opposite 115 VAC, the power circuits are automatically programmed for operation from a 115V/60 Hz source – 3A Slo-Blo fuse.
16	Input Power Receptacle	When connected to appropriate power source, supplies ac power to 9515B oscillator.
17	Fuse and Fuse-Release Lever	When FUSE PULL lever is moved outward, one end of fuse is removed from holder – replace fuse in accordance with position of line voltage switch (15).

2-34. MINIMUM PERFORMANCE STANDARDS

2-35. The minimum performance standards provide a quick and easy method of determining whether or not the instrument or system is performing within specified limits. Test equipment and other accessories required to performance test the 6600/9514B/9515B system are listed in Table 2-6. The performance standards are described in Table 2-7 through 2-20. If the system does not perform as specified, refer to Sections III and IV for circuit analysis and maintenance procedures.

TABLE 2-6. RECOMMENDED TEST EQUIPMENT

Test Equipment	Critical Specifications	Manufacture and Model
Network Analyzer	At least 10 MHz to 18 GHz, -40 dBm to +20 dBm	Singer 8000/7051
Frequency Counter	At least 10 MHz to 18 GHz, sensitivity < 4 mW	EIP 351D
Spectrum Analyzer	10 MHz to 40 GHz	Singer SPA-3000
Oscilloscope	Sweep from <100 nsec/Div. to > 10 sec/ Div. External Trigger	Tektronix 547 Series
Oscilloscope Plug-in	Sensitivity: 50 μV or less/cm Frequency: dc to 50 MHz	Tektronix Type 1A7 Tektronix Type 1A1
Power Meter and Thermistor Mount	Power range: 100 μW to 10 mW Frequency range: 10 MHz - 18 GHz	Singer, Model 1008
Digital Voltmeter	Accuracy ±0.004%, 1 mV to 200V	Fluke 8300A
Attenuator Pad	10 dB (dc - 18 GHz)	Weinschel Model 1-10
Crystal Detector (2)	10 MHz - 18 GHz	Singer 1008 or H-P 8470A with female and male connectors
Directional Couplers	10-1000 MHz, 10 dB 1.0-4.2 GHz, 10 dB 3.0-12.4 GHz, 10 dB 12-18 GHz, 11 dB	Singer 1170-10-2 Singer 1173-10-2 Singer 1176-10-2
Marker Generator	100, 25 and 5 MHz Marker	Singer Model 7300
Resistive Power Divider	6 dB loss, dc-18 GHz	Weinschel Model 1506A
True RMS Voltmeter	10 Hz to at least 150 kHz. TRMS response; sensitivity at least 1 mV.	H-P Model 13400A
Pulse Generator	Positive and negative pulses (0-10V): Rise/Fall Time <5 nsec. Pulse width and repetition rate variable 50% output resistance	Data Pulse 101
50Ω BNC Feedthrough Termination	50Ω dc resistance to ground, dc to 100 MHz frequency range	Tektronix 011-0049-01
Function Generator	0.02 Hz to 2 MHz sinusoidal output 10 ms sawtooth	Wavetek 134

TABLE 2-6. RECOMMENDED TEST EQUIPMENT (CONT'D)

Service Kit for Model 6600(A)	Singer P/N 102-0200-001
1 - Model 6602 Test Plug-in	103-2701-001
1 - Model 6602A Extender Plug-in	952-910
1 - PCB Extender, non-heatsink	103-2230-001
1 - PCB Extender, heatsink	103-2231-001
2 - Extension Cables DIP connectors (male to male)	102-9205-001
1 - Extension Cable, Power Supply	102-9206-001
1 - Lamp Extractor tool	175-003-001
Service Kit for Model 9515	Singer P/N 102-0211-001
1 - PCB Extender (28 Pin) A7 thru A11	102-0202-001
1 - PCB Extender (28 Pin) A12	102-0202-002
1 - PCB Extender (28 Pin) A13	102-0202-003
1 - Extender, Heatsink	102-0204-001
1 - PCB Extender (36 Pin) A1 thru A6)	102-0201-001

TABLE 2-7. FREQUENCY RANGE AND ACCURACY – PERFORMANCE TEST

SPECIFICATION: Frequency bands and in-band accuracies as follows.

Frequency Range: 2-18 GHz

Frequency Bands:

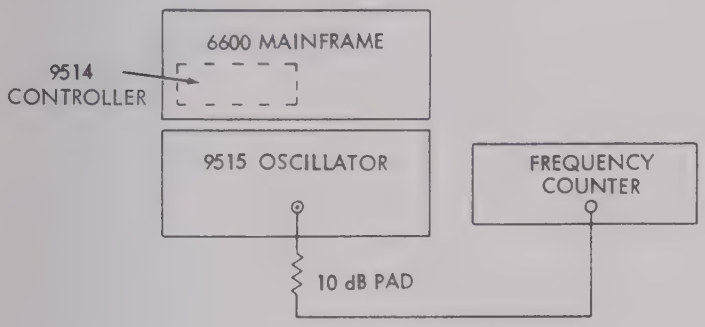
Band 4	2-8 GHz	Band 6	8-18 GHz
Band 5	4-12 GHz	Band 7	2-18 GHz

Frequency Accuracy:

Bands 4 through 6	±1%
Band 7	±2%

DESCRIPTION: Frequency Ranges and Frequency Accuracy at room temperature are reached by using a frequency counter to measure the frequency at the extremes of each band, and at other frequencies, if required.

TEST SETUP:



PROCEDURES:

Step 1: Press CW pushbutton (8, Figure 2-3); release all other pushbuttons on 6600 mainframe.

Step 2: Press LEVELING INT pushbutton (5, Figure 2-2) on 9515 oscillator and FREQ RANGE GHz 0.1-2 pushbutton (3, Figure 2-1) on 9514 controller. Adjust LEVEL CONTROL on the controller until UNLEVELED WHEN LIT indicator just goes out.

Step 3: In the listing below, precisely set the F_o (center frequency) marker under each frequency in the "test frequency" column; select the proper frequency range at the controller and make certain the correct frequency dial is installed in the 6600 mainframe. Observe that readout on frequency counter is between the specified lower-and-upper frequency limits; check each frequency to ensure that the swept oscillator is properly aligned.

Test Frequency	Lower Limit (MHz)	Upper Limit (MHz)
2-to-8 GHz Range:		
2.0 GHz	1980	2020
3.9 GHz	3861	3939
4.1 GHz	4059	4141
8.0 GHz	7920	8080
4-to-12 GHz Range:		
4.0 GHz	3960	4040
7.9 GHz	7821	7979
8.1 GHz	8019	8181
12.0 GHz	11880	12120

TABLE 2-7. FREQUENCY RANGE AND ACCURACY – PERFORMANCE TEST (CONT'D)

PROCEDURES: Continued

Test Frequency	Lower Limit (MHz)	Upper Limit (MHz)
8-to-18 GHz Range:		
8.0 GHz	7920	8080
11.9 GHz	11781	12019
12.2 GHz	12078	12322
18.0 GHz	17820	18180
2-to-18 GHz Range:		
2.0 GHz	1980	2020
3.9 GHz	3822	3978
4.1 GHz	4018	4182
7.9 GHz	7742	8058
8.1 GHz	7938	8262
11.9 GHz	11662	12138
12.2 GHz	11956	12444
18.0 GHz	17640	18360

TABLE 2-8. SWEEP WIDTH ACCURACY – PERFORMANCE TEST

SPECIFICATION:

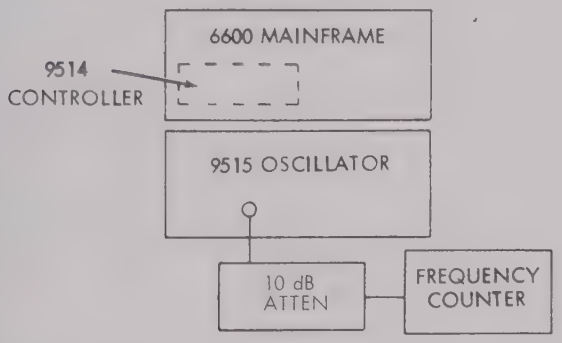
Full Band Sweep: Frequency End Points, accuracy equals CW, accuracy ±1%.

M1 - M2 Sweep: Frequency End Points, accuracy equals CW, accuracy ±1%.

ΔF Sweep: ±2% of ΔF (maximum deviation) plus ±1% of maximum full-band ΔF.

DESCRIPTION: The sweep width accuracy is first determined statically using the manual scan mode and measuring the frequency at the 2 extremes of the "manual scan" potentiometer. The microwave spectrum analyzer is then adjusted to the particular frequency end points of the sweep in the manual scan mode, and then, using the 1 sec sweep time, the actual extremes of the sweep range determined.

TEST SETUP:



PROCEDURES:

Step 1: Connect equipment as shown in Test Setup.

Step 2: Press FULL BAND pushbutton on 600 mainframe to select full-band sweep; press FREQ RANGE GHz 2-8 pushbutton on 9514 controller. Pull out MANUAL SWEEP control and turn fully counterclockwise. Observe that counter reads 2 GHz (±20 MHz). Turn sweep control fully clockwise; observe that counter reads 8 GHz (±80 MHz).

Step 3: Press FREQ RANGE GHz 4-12 pushbutton on 9514 controller and repeat 2. Observe that counter reads 4 GHz (±40 MHz) for counterclockwise position of sweep control and 12 GHz (±120 MHz) for clockwise position of control.

Step 4: Press FREQ RANGE GHz 8-18 pushbutton on 9514 controller and repeat step 2. Observe that counter reads 8 GHz (±80 MHz) for counterclockwise position of sweep control and 18 GHz (±180 MHz) for clockwise position of control.

Step 5: Press FREQ RANGE GHz 2-18 pushbutton on 9514 controller; observe that counter reads 2 GHz (±40 MHz) at the low end and 18 GHz (±360 MHz) at the high end.

Step 6: Press M1-M2 pushbutton on mainframe to select marker sweep. Press FREQ RANGE GHz 2-8 pushbutton on 9514 controller; set M1 marker to 2 GHz and M2 marker to 8 GHz. Pull out MANUAL SWEEP control and turn fully counterclockwise. Observe that counter reads 2 GHz (±20 MHz). Turn sweep control fully clockwise; observe that counter reads 8 GHz (±80 MHz).

Step 7: Press FREQ RANGE GHz 4-12 pushbutton on 9514 controller; set M1 marker to 4 GHz and M2 marker to 12 GHz. Repeat step 6 and observe that tolerances agree with those given in step 3.

Step 8: Press FREQ RANGE GHz 8-18 pushbutton on 9514 controller; set M1 marker to 8 GHz and M2 marker to 18 GHz. Repeat step 6 and observe that tolerances agree with those given in step 4.

Step 9: Press FREQ RANGE GHz 2-18 pushbutton on 9514 controller; set M1 marker to 2 GHz and M2 marker to 18 GHz. Observe that counter reads 2 GHz (±40 MHz) at the low end 18 GHz (±360 MHz) at the high end.

TABLE 2-8. SWEEP WIDTH ACCURACY – PERFORMANCE TEST (CONT'D)

Step 10: Press $F_o/\Delta F$ pushbutton on sweeper mainframe and press FREQ RANGE GHz 2-8 pushbutton on 9514 controller. Turn ΔF control until ΔF "bug" is centered on 10 percent (±5% symmetrical sweep about F_o). Tune F_o to some center-scale frequency – say 5 GHz, as indicated by the counter. The points of swept window about 5 GHz are ±5% of full-band sweep; thus, 5% of 6 GHz = 300 MHz, that is, 5 GHz + 300 MHz and 5 GHz - 300 MHz.

Step 11: Pull out MANUAL SWEEP control and turn fully counterclockwise; observe that counter reads, as a maximum, 4.7 GHz (+18 MHz) and, as a minimum, 4.7 GHz (-18 MHz). Calculations are as follows: ±2% of ΔF (maximum deviation) = ±2% of 600 MHz = ±12 MHz plus ±1% of maximum F = ±10% of 6 GHz = ±1% of 500 MHz + ±6 MHz; thus 12 + 6 = 18 MHz.

Step 12: Repeat step 11 with MANUAL SWEEP control fully clockwise. Observe that counter reads, as a maximum, 5.3 GHz (+18 MHz) and, as a minimum, 5.3 GHz (-18 MHz).

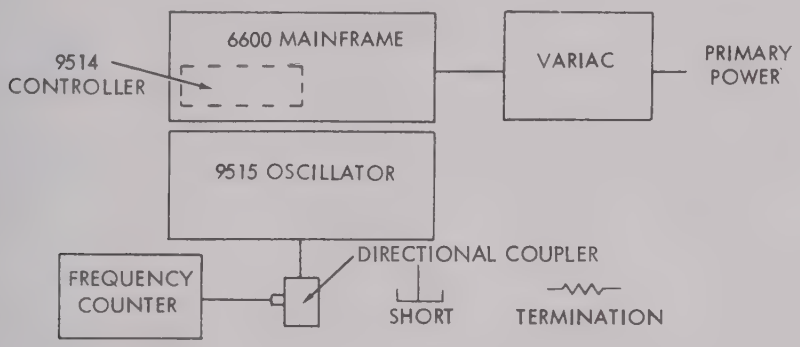
TABLE 2-9. FREQUENCY STABILITY WITH LOAD CHANGE – PERFORMANCE TEST

SPECIFICATIONS: Frequency Stability with maximum change in load impedance (short to terminated to open):

Band 4	1 MHz
Band 5	1 MHz
Band 6	1 MHz
Band 7	1 MHz

DESCRIPTION: A directional coupler with a coupling factor of at least 16 dB is connected to the sweeper output with the counter connected to the side arm output. The main arm output of the coupler is then shorted, terminated, or left open and the frequency change measured at maximum leveled power output.

TEST SETUP:



PROCEDURES:

Step 1: Connect equipment as shown in test setup.

Step 2: Select band 7, push F_o button and with the coupler main arm terminated, set frequency precisely at 5.00 GHz. Take reading (#1), remove termination, take a reading again (#2), connect the short, take a reading (#3), remove the short, and connect the termination again, and take the final reading (#4), calculate the frequency change in the following way:

$$\Delta F = 1/3 \quad (|F_1 - F_2|) + (|F_2 - F_3|) + (|F_3 - F_4|)$$

Step 3: Repeat step 2 at 3 GHz, 10 GHz, 15 GHz. The values should always be smaller or equal to the specified values.

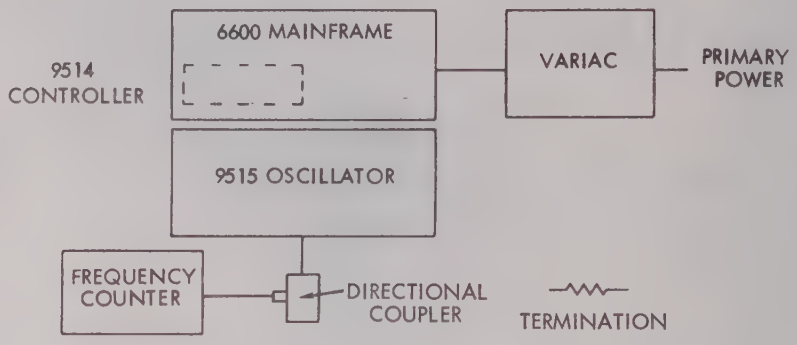
TABLE 2-10. FREQUENCY STABILITY WITH LINE VOLTAGE CHANGE – PERFORMANCE TEST

SPECIFICATION:

Band 4	20 kHz
Band 5	20 kHz
Band 6	20 kHz
Band 7	40 kHz

DESCRIPTION: The frequency change of the terminated sweeper in the F_o mode is measured with the line voltage varied between 105 VAC and 125 VAC.

TEST SETUP:



PROCEDURES:

Step 1: Connect termination to main arm output of the directional coupler with the variac output set to 115 VAC. Select band 4 and set F_o to 2 GHz.

Step 2: Take frequency reading (#1), increase frequency voltage to 125 VAC, wait 30 sec, take another reading (#2), and increase voltage back to 115 VAC, wait 30 sec and take final reading (#3). Calculate average of frequency changes:

$$\Delta F = 1/4 \quad (1\,F_1 - F_2\,1) + (1\,F_2 - F_3\,1)$$

This average change should be less than the specified values.

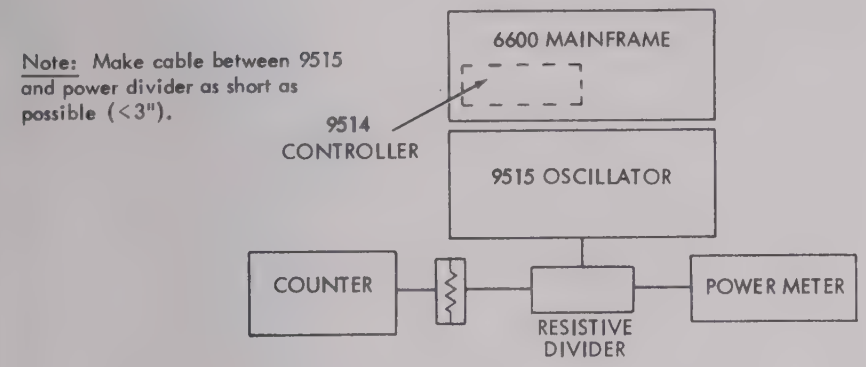
TABLE 2-11. FREQUENCY STABILITY WITH 10 dB LEVEL CHANGE – PERFORMANCE TEST

SPECIFICATION:

Band 4	1 MHz
Band 5	1 MHz
Band 6	1 MHz
Band 7	1 MHz

DESCRIPTION: The frequency change of the terminated sweeper in the F_o mode is measured with the power level varied by 10 dB starting from maximum leveled power, using the power level control of the 9514.

TEST SETUP:



PROCEDURES:

Step 1: Connect equipment as shown in test setup; select band 4 and set F_o to 3 GHz.

Step 2: Keep F_o pushbutton depressed and adjust power level control on the 9514 until power meter indicates 2.5 milliwatts. Measure frequency and then turn power level control counterclockwise until power-meter reading decreases 10 dB (0.25 mW).

Step 3: Take reading again. Increase power level back to 2.5 mW. Take third reading. Calculate average frequency change:

$$\Delta F = 1/2 \quad (| F_1 - F_2 |) + (| F_2 - F_3 |)$$

Step 4: Repeat for all bands. The changes should be smaller than the specified values.

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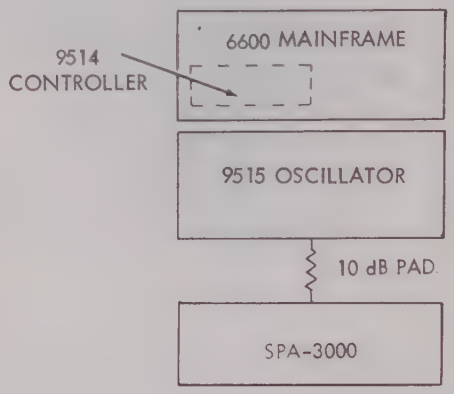
TABLE 2-12. RESIDUAL FM – PERFORMANCE TEST

SPECIFICATION:

Frequency Range	Residual FM (CW Mode)
2-to-4 GHz	<10 kHz
4-to-8 GHz	<15 kHz
8-to-12.4 GHz	<25 kHz
12.4-to-18 GHz	<30 kHz

DESCRIPTION: Peak Residual FM is defined as one half of the peak-to-peak variations of the CW frequency when measured with a frequency discriminator with a post detection bandwidth of 1 Hz to 20 kHz.

TEST SETUP:



PROCEDURES:

Step 1: Connect equipment as shown in test setup.

Step 2: Set F_o to 2 GHz and adjust spectrum analyzer display until sweeper frequency is centered. Set controls of spectrum analyzer as follows:

Dispersion	20 kHz/Div
IF Bandwidth	10 kHz
Sweep Speed	10 μsec/Div
Display	Logarithmic
Sweep	Internally triggered

Step 3: The random frequency fluctuations show themselves as a broadened frequency spectrum. Determine the width of this spectrum (about 10 dB below the peak) by visual averaging over a period of 10-seconds and call it ΔF microseconds in kHz. The residual FM is then:

$$\text{FM res} = \frac{\Delta F \text{ meas (kHz)} - 10 \text{ kHz}}{2}$$

Step 4: Repeat this measurement at 3 GHz, 6 GHz, 10 GHz and 15 GHz; measure at the frequencies >2 GHz both in the single band and broadband mode. The measured values should be smaller than the specified ones.

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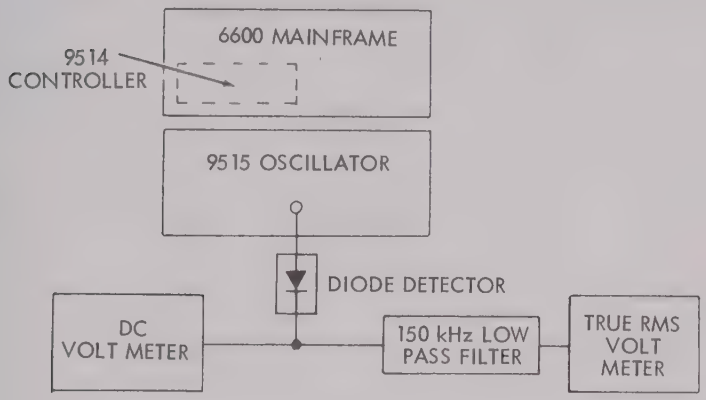
TABLE 2-13. RESIDUAL AM – PERFORMANCE TEST

SPECIFICATION: Residual AM at least 50 dB below the signal in a 150 kHz bandwidth at maximum leveled power in the leveled mode of operation.

DESCRIPTION: The residual AM is defined as the rms level of the AM noise as measured with a linear detector having a post detection bandwidth of 150 kHz, with the leveling active and the power level set to maximum. The measurement is performed by measuring the rms noise level at the output of a point-contact diode operating at 5 mW or greater power, where it behaves like a linear detector for the small amplitude variations which constitute the AM noise. In order to avoid the AM caused by the power variation of the sweeper in the sweeping mode, the measurement is performed in the F_o mode.

TEST SETUP:



PROCEDURES:

Step 1: Connect equipment as shown in test setup.

Step 2: Press CW pushbutton and select band 4 at controller; tune instrument to 2 GHz. (Note: Check that AM and RF MARKER pushbuttons are released and that no AC signal, other than input power, is connected at the rear panel; remove any pulse modulation input at the front panel.

Step 3: Adjust power to a level just below where the UNLEVELED WHEN LIT indicator goes on. Measure the dc output of the diode detector (approximately 700 millivolts). Measure the voltage as indicated by the TRMS voltmeter; it should be less than 0.313-percent of the dc voltage. For instance, with a dc voltage of 700 millivolts, the measured ac voltage must not exceed 2.2 millivolts rms.

TABLE 2-14. HARMONICS AND NON-HARMONIC EMISSIONS – PERFORMANCE TEST

SPECIFICATION:

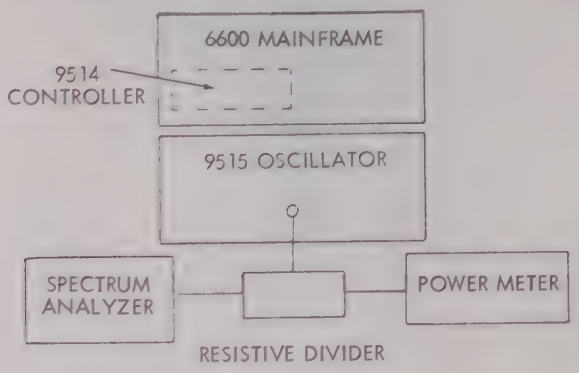
Harmonics: More than 20 dB below carrier at maximum leveled power setting.

Non-Harmonics:
2-18 GHz: More than 50 dB below carrier at maximum leveled power setting.

4-8 GHz: More than 35 dB below carrier at maximum leveled power setting.

DESCRIPTION: Harmonic and non-harmonic emissions are defined as spurious responses that may or may not be harmonically related to the fundamental (F_o) frequency. Closely follow the identification procedures below, since spurious signals can result from defective test equipment, radiated pickup, and other extraneous sources.

TEST SETUP:



PROCEDURES:

Step 1: Connect equipment as shown in test setup.

Step 2: Set analyzer to 200 MHz/Div dispersion, IF Bandwidth to 100 kHz, and scan speed to 3 msec/Div. Select band 7, push F_o button, and slowly tune F_o from 2 GHz to 18 GHz, readjusting the center frequency of the analyzer to see at least the second and third harmonic of the sweeper output. Use the spectrum analyzer in the log display and adjust RF and IF attenuators so that the F_o signal produces a full scale CRT deflection. If a harmonic or non-harmonic signal is found, use the signal identifier and the RF attenuator of the analyzer to ascertain that it is not a spectrum analyzer created signal, but a signal emanating from the sweeper under test; all unwanted signals should be equal or lower than the levels specified.

TABLE 2-15. OUTPUT POWER LEVEL – PERFORMANCE TEST

SPECIFICATION:

Power Output (Leveled):

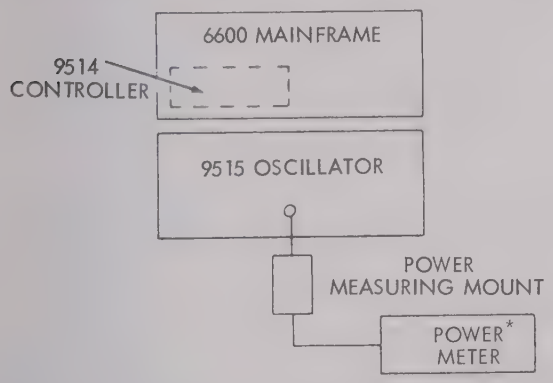
Minimum of 5 mW (standard) over frequency range of 2 to 18 GHz with adjustment range of 10 dB.

Minimum of 10 mW (Option 10) over frequency range of 2 to 18 GHz with adjustment range of

Minimum of 20 mW (Option 20) over frequency range of 2-to-18 GHz with adjustment range of 10 dB and 10 mW over a frequency range of 10 MHz-to-2 GHz.

DESCRIPTION: The power output and the adjustable range are measured using a microwave power meter. The specified power levels are defined as "the power dissipated in a perfect 50Ω load." The correction factor, used to calculate the RF power level from the power meter reading, therefore should be the "Calibration Factor", which is defined as the ratio of power level indicated on the power meter, to the RF power level incident upon the power measuring mount. If the power measuring mount is calibrated in effective efficiency a mismatch correction might have to be applied whenever the measured power level is equal or below the specified level.

TEST SETUP:



*If applicable, correct power meter readings in accordance with the calibration chart furnished with the instrument.

PROCEDURES:

Step 1: Connect equipment as shown in test setup.

Step 2: Release front-panel RF MARKER pushbutton (22, Figure 2-3). Connect power measuring mount directly to RF OUTput connector (1, Figure 2-2). Select 2-18 GHz frequency range and press FULL BAND pushbutton (13, Figure 2-3) to initiate full-band sweep. Use a 100-millisecond sweep and adjust LEVEL CONTROL (4, Figure 2-1) until UNLEVELED WHEN LIT indicator is extinguished.

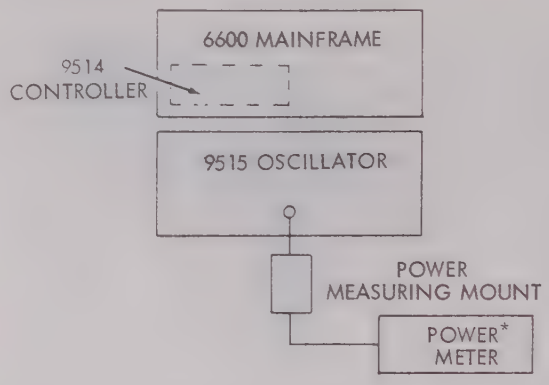
Step 3: Press CW pushbutton (8, Figure 2-3) and, while watching power meter, slowly tune from one end of the band to the other. The lowest reading on power meter should be equal to or exceed the specified values.

TABLE 2-16. FLATNESS OF POWER OUTPUT (INTERNALLY LEVELED) – PERFORMANCE TEST

SPECIFICATION: With the system operating at maximum leveled power output, the RF power dissipated in a 50-ohm load varies less than 3 dB peak-to-peak from 2 to 18 GHz at a sweep time of 35-milliseconds

DESCRIPTION: The leveled power output is measured with a microwave power meter. To calculate the RF power from the power meter reading, a correction factor is required. This correction (calibration factor) is defined as the ratio of power level indicated on the power meter to the RF power level incident upon the power measuring mount. (Note: If the power measuring mount is calibrated in effective efficiency, a mismatch correction may be required when the measured power level is equal to or below the specified level.)

TEST SETUP:



*If applicable, correct power meter readings in accordance with the calibration chart furnished with the instrument.

PROCEDURES:

Step 1: Connect equipment as shown in test setup.

Step 2: Release front-panel RF MARKER pushbutton (22, Figure 2-3). Connect power measuring mount directly to RF OUTput connector (1, Figure 2-2). Select 2-18 GHz frequency range and press FULL BAND pushbutton (13, Figure 2-3) to initiate full-band sweep. Use a 35-millisecond sweep and adjust LEVEL CONTROL (4, Figure 2-1) until UNLEVELED WHEN LIT indicator is extinguished.

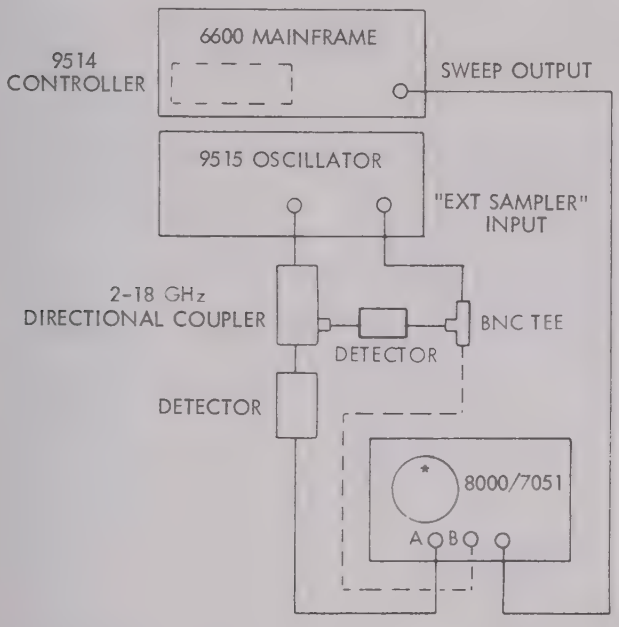
Step 3: Press CW pushbutton (8, Figure 2-3) and, while watching power meter, slowly tune from one end of the band to the other. The peak-to-peak power variation should not exceed 3 dB. Adjust LEVEL CONTROL (4, Figure 2-1) for a power reduction of 10 dB; repeat power variance measurement and observe that the 3 dB peak-to-peak variation is not exceeded.

TABLE 2-17. FLATNESS OF POWER OUTPUT (EXTERNALLY LEVELED) – PERFORMANCE TEST

SPECIFICATION: When referenced to dc-output voltage of sampler detector (independent of diode polarity) and, with 35-millisecond sweep time, the RF output is leveled with ±0.1 dB in all bands. (Note: To meet this specification, the detector output voltage must be between 40-and-200 millivolts.)

DESCRIPTION: The RF output of the oscillator is externally sampled, detected, and compared to a preset reference. The amplitude differential is continuously displayed on a network analyzer. For optimum results, the coupler must be flat over the frequency range of interest and all connecting hardware must be of the highest professional quality.

TEST SETUP:



*Make sure by using the calibrator output that the CRT is properly aligned, otherwise, a constant input voltage will not produce a true horizontal line.

PROCEDURES:

Step 1: Connect equipment as shown in test setup.

Step 2: Press LEVELING EXT pushbutton (6, Figure 2-2) on oscillator and select sweep time of 100-milliseconds. Press FULL BAND pushbutton (13, Figure 2-3) and calibrate channel A of network analyzer with sensitivity set to 1.0 dB per division. Set LEVEL CONTROL (4, Figure 2-1) to three o'clock position and adjust front-panel GAIN control on oscillator until output is leveled, that is, channel A trace is stable and UNLEVELED WHEN LIT indicator is just past the stay-extinguished threshold. Switch to channel Band calibrate trace with sensitivity set to 0.5 dB per division. The channel B trace displays the output of the external leveling loop and should be a straight-line trace with no peak-to-peak variations greater than 0.2 dB.

Step 3: Change sweep time to 35-milliseconds and repeat step 2.

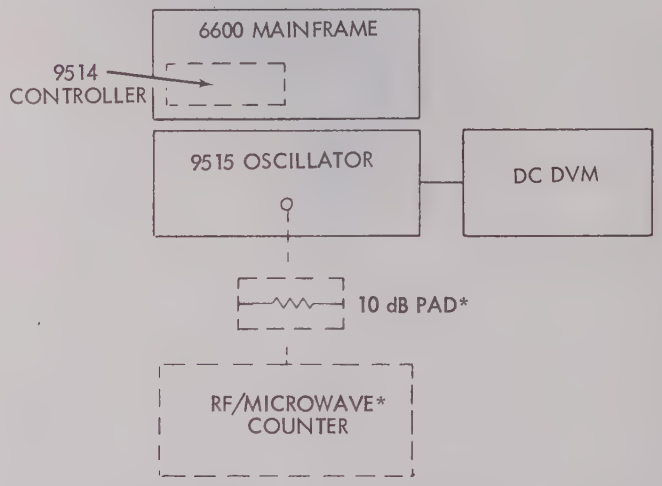
TABLE 2-18. ACCURACY OF V_{pf} (VOLTAGE PROPORTIONAL TO FREQUENCY) – PERFORMANCE TEST

SPECIFICATION: The V_{pf} output voltage of the 9515 oscillator into a 100K-ohm load is as follows:

Band	Frequency Range	Sensitivity	Accuracy
4/5/6	2-8/4-12/8-18 GHz	1V/GHz	±2%
7	2-18 GHz	1V/GHz	± (2% + 40 mV)

DESCRIPTION: A digital voltmeter connected to V_{pf} connector 14 (14, Figure 2-4) numerically indicates the nominal output frequency. For instance with band 4 selected and the frequency tuned to the lowest cardinal scale marking, the V_{pf} voltage should be 1.96 volts as a minimum and 2.04 volts as a maximum. (Note: The frequency and the V_{pf} are two independent functions, that is, the V_{pf} voltage can be within specified limits and, at the same time, the frequency can be outside of specified limits.)

TEST SETUP:



*If desired, a 10 dB pad and precision microwave counter (dotted line) can be used to verify frequency accuracy.

PROCEDURES:

Step 1: Connect equipment as shown in test setup.

Step 2: Select 2-8 GHz at 9514 controller. Press CW pushbutton and tune F_o to lowest cardinal marking on scale; check that DVM reads between 1.96-and-2.04 volts and Tune F_o to highest cardinal marking on dial; observe that DVM reads between 7.84-and-8.16 volts.

Step 3: Select 4-12 GHz at controller, repeat step 2. With F_o tuned to the lowest scale number, observe that DVM reads between 3.92-and-4.08 volts and between 11.76-and-12.24 volts when F_o is tuned to the highest number.

Step 4: Select 8-18 GHz at controller, repeat step 2. With F_o tuned to the lowest scale number, observe that DVM reads between 7.84-and-8.16 volts and between 17.64-and-18.36 volts when F_o is tuned to the highest number.

Step 5: Select 2-18 GHz at controller, repeat step 2. With F_o tuned to the lowest scale number, observe that DVM reads between 1.96-and-2.08 millivolts and between 17.6-and-18.4 volts when F_o is tuned to the highest number.

TABLE 2-19. SWEEP CHARACTERISTICS – PERFORMANCE TEST

SPECIFICATION:

Calibrated Sweep Times: 10 msec, 100 msec, 1 sec, 10 sec, accuracy ±5%.

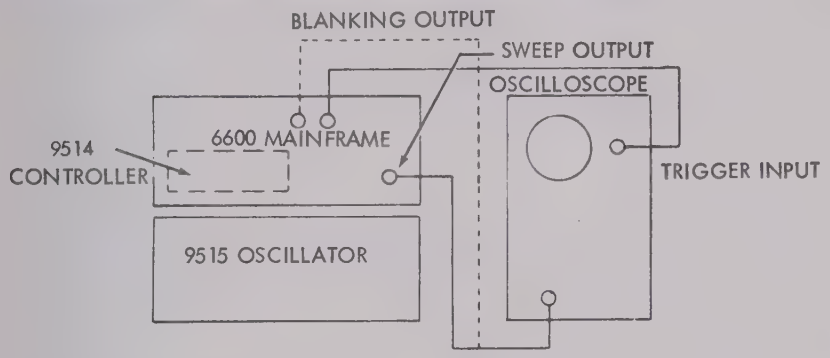
Flyback Times: 4 msec or 2 msec for 10 msec sweep sine range, accuracy ±30%.
10% of sweep time at 100 msec, 1 sec, 10 sec, accuracy ±20%.

Dwell Times:
At beginning and end of sweep: 4 msec for 10 msec, 100 msec, 1 sec sweeps, accuracy ±50%.
200 msec for 10 sec sweep time; accuracy ±50%.
At frequency switch points: 2 msec ±50%.

Blanking Signal (rear panel output connectors):
"+" Outputs: +10V (±2V) during retrace period. 0V (±0.5V) during any other time.
"-" Outputs: -10V (±2V) during retrace period. 0V (±0.5V) during any other time.

DESCRIPTION: All the sweep characteristics are measured with an oscilloscope since the time base and vertical accuracies of a well calibrated oscilloscope suffice.

TEST SETUP:



PROCEDURES:

Step 1: Connect equipment as shown in test setup.

Step 2: Set up oscilloscope for external frequency triggering. Use the unused blanking output as frequency source. Use only calibrated deflection position. Push 10 msec, 100 msec, 1 sec, 10 sec sweep time button and measure dwell time at beginning of sweep, dwell time at frequency switching points, dwell time at end of sweep, retrace time, and blanking outputs.

TABLE 2-20. AMPLITUDE MODULATION – PERFORMANCE TESTS

SPECIFICATION:

INTERNAL SQUAREWAVE MODULATION:

Modulation Frequency: 1000 Hz adjustable at least from 950 Hz to 1050 Hz
Rise or Fall Times of Squarewave:
Leveled Operation: < 15 μsec
Unleveled Operation: < 2 μsec
On/Off Ratio: > 45 dB

EXTERNAL SQUAREWAVE OR PULSE MODULATION (MAIN FRAME)

Modulation or Pulse Repetition Frequency Range:
Leveled Operation: DC-3 kHz
Unleveled Operation: DC-100 kHz
Rise or Fall Times of Squarewave:
Leveled Operation: < 15 μsec
Unleveled Operation: < 2 μsec
On/Off Ratio: > 45 dB
Range of squarewave generator output resistance to turn RF power off with no signal from modulation generator: 2 - 200Ω
Modulation Sensitivity: ≥ +2V/45 dB (5V max. input)

EXTERNAL PULSE MODULATION USING INTERNAL MODULATOR (9515)

Modulation or Pulse Repetition Frequency Range: DC to 30 kHz
Rise or Fall Times of Pulse Modulation:
Leveled Operation: < 20 μsec
Unleveled Operation: < 2 μsec
On/Off Ratio: > 45 dB
Modulation Sensitivity: ≥ +2V/45 dB or 300 mW maximum

EXTERNAL PULSE MODULATION DRIVER (9515) FOR EXTERNAL PULSE MODULATOR
Pulse Repetition Frequency Range: DC - 1 MHz
Rise or Fall Times of Pulse: <15 nsec, depending on PIN switch used
Minimum Pulse Width: 50 nsec
Polarity of PIN Switch: Internally switchable

DESCRIPTION: All pulse modulation tests are performed with a nominally linear AM detector, having a frequency response dc - 50 MHz (3 dB). This wideband modulation frequency characteristic is obtained by shunting the BNC cable between diode detector and oscilloscope input by 50Ω and restricting the length of the cable to 3 feet. To obtain the linear detection characteristic, the input power to the diode detector should be at least 5 mW, or maximum leveled power in the 10 mW (Opt .10) or 20 mW (Opt. 20) systems.

TEST SETUP #1

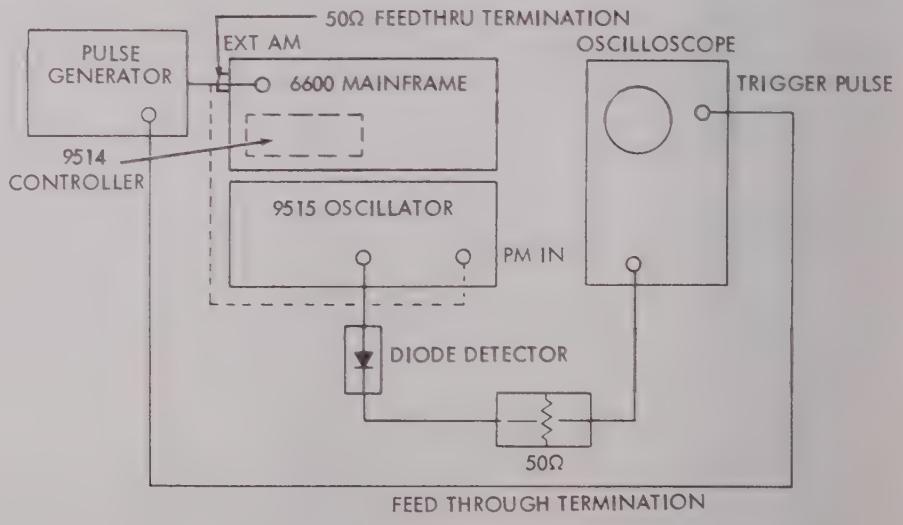


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TABLE 2-20. AMPLITUDE MODULATION PERFORMANCE TESTS (CONT'D)

PROCEDURES – Internal Squarewave Modulation

Step 1: Connect equipment as shown in Test Setup #1.

Step 2: Set rear-panel AM MODE switch (10, Figure 2-4) to INT SQWAVE and press RF AM pushbutton (21, Figure 2-3). Adjust oscilloscope for a stable squarewave display.

Step 3: Press LEVELING INT pushbutton (5, Figure 2-2) and adjust LEVEL CONTROL (4, Figure 2-1) until UNLEVELED WHEN LIT indicator just goes out.

Step 4: Use internal scope trigger and measure time interval between 10-and-90 percent points on leading edge of pulse; perform identical measurement of the trailing edge. In each case, the measured time-interval should be less than 20-microseconds.

Step 5: Press the LEVELING UNLEV pushbutton (4, Figure 2-2) and repeat step 4; in each case, the measured time-interval should be less than 2-microseconds.

PROCEDURES – External Squarewave Modulation

Step 1: Set rear-panel AM MODE switch (10, Figure 2-4) to external and press LEVELING INT pushbutton (5, Figure 2-2). Adjust amplitude of generator until a stable squarewave is obtained at output of diode detector.

Step 2: Repeat step 4 of the internal-squarewave modulation procedures. Observe that both the rise and fall times are less than 20-microseconds. (Note: With the generator turned off, the RF output power drops to at least 45 dB below the internally-leveled output - with the specified control settings, the RF output simply drops to zero.)

Step 3: Readjust generator controls for a pulse width of 50-microseconds and a repetition rate of 3 kHz. Verify the detected signal still resembles a 10 kHz squarewave with approximately the same peak-to-peak amplitude as at 1 kHz, although with rounded corners due to the 20-microsecond rise and fall times.

Step 4: Press the LEVELING UNLEV pushbutton (4, Figure 2-2) and check that neither the rise or fall time exceeds 2 microseconds.

Step 5: Decrease the pulse width to 10-microseconds and set the repetition frequency to 50 kHz; verify that the detected signal still resembles a 50 kHz squarewave with approximately the same peak-to-peak amplitude as at 3 kHz.

TEST SETUP #2

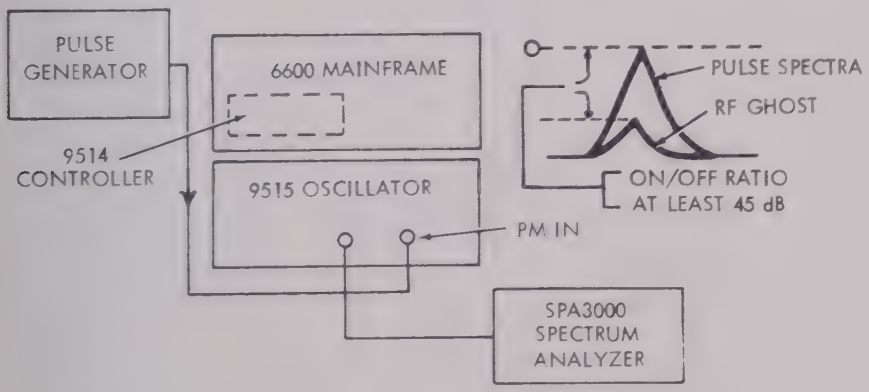


TABLE 2-20. AMPLITUDE MODULATION – PERFORMANCE TESTS (CONT'D)

PROCEDURES – External Squarewave and Pulse Modulation Using Internal Modulator of 9515 Oscillator

Note. Operation of the modulator with an external squarewave source should be identical to that described in "PROCEDURES – External Squarewave Modulation." To verify pulse-modulation capability, perform the procedures that follow.

Step 1: Connect pulse generator to front-panel PM IN connector (8, Figure 2-2) and press PM pushbutton.

Step 2: In the leveled mode of operation, check that neither the rise or fall times exceed 20-microseconds. In the unleveled mode of operation, check that neither the rise or fall times exceed 2-microseconds.

PROCEDURES – 9515 External PM Driver for External Pulse Modulator

Step 1: Disconnect crystal detector from the oscilloscope and connect it to PM OUTput connector (2, Figure 2-2).

Step 2: Set generator controls for a 3 kHz pulse train - each pulse 1-microsecond wide. Check that output-pulse amplitude into a 50-ohm feedthrough load is constant at about 5-volts and is independent of input-pulse amplitude. Pulse risetime should be less than 10-nanoseconds and the achievable pulse width should be less than 100-nanoseconds.

SECTION III
MAINTENANCE

3-1. CONTENT

3-2. This section contains all the information required to adjust, troubleshoot, and repair the 9514 controller and the 9515 oscillator; procedures for verifying "system" performance (Minimum Performance Standards) are presented in Section 2. Besides the generalized information that follows, other service information is organized as shown in Table 3-1.

3-3. ENVIRONMENTAL CONSIDERATIONS

3-4. The 9514/9515 System is designed for normal laboratory environments, but it is not seriously affected by wide ranges of temperature. After long storage at temperatures in the vicinity of 75°C, or in high-humidities, the system should be tested in accordance with the "Minimum Performance Standards" described in Section 2.

TABLE 3-1. TROUBLESHOOTING AND REPAIR INFORMATION

Figure No.	Description	Page No.
3-6	9514B/9515B Wideband Swept Oscillator – Overall Block Diagram	3-9
3-7	9514B Controller with Schematic Diagram	3-11
3-8	9514B/9515B Leveling Loop with Functional Analysis	3-13
3-9	P/O PM and Leveling #2 Board A3 – Schematic Diagram	3-16
3-10	5-Pole PIN Switch – Schematic Diagram	3-18
3-11	Remote Leveling Board A1 – Schematic Diagram	3-19
3-12	Pulse Modulation and Leveling #2 Board A3 – Schematic Diagram	3-20
3-13	Frequency Modulation Board A2 – Schematic Diagram	3-21
3-14	Connector Board A5 – Schematic Diagram	3-22
3-15	Band Control Logic Board A6 – Schematic Diagram	3-24
3-16	YIG Driver Board A8 (0.01-4 GHz) Schematic Diagram	3-26
3-17	YIG Driver A9 (4-8 GHz) – Schematic Diagram	3-29
3-18	VTO Driver A9 (4-8 GHz) – Schematic Diagram	3-31
3-19	YIG Driver A10 (8-12 GHz) – Schematic Diagram	3-33
3-20	YIG Driver A11 (12-18 GHz) – Schematic Diagram	3-34
3-21a	Regulator #2 Board A12 – Schematic Diagram	3-35
3-21b	Regulator #2 Board A12 – Schematic Diagram	3-36
3-22	Regulator #1 Board A13 – Schematic Diagram	3-38
3-23	Power Supply Board A14 – Schematic Diagram	3-39
3-24	Mother Board A15 – Schematic Diagram	3-40
3-25	RF Interconnect Diagram – 0.01-18 GHz	3-41

3-5. GENERAL SERVICE INFORMATION

3-6. Basic Transistor Operation. The 9514B/9515B plugins use solid-state electronics in such circuit configurations as oscillators, amplifiers, and special-function circuits that are unique to sweeper systems. Basic transistor/diode operation is applicable to all of these circuits; a brief summary of these components and their general characteristics are described and illustrated in the paragraphs that follow.

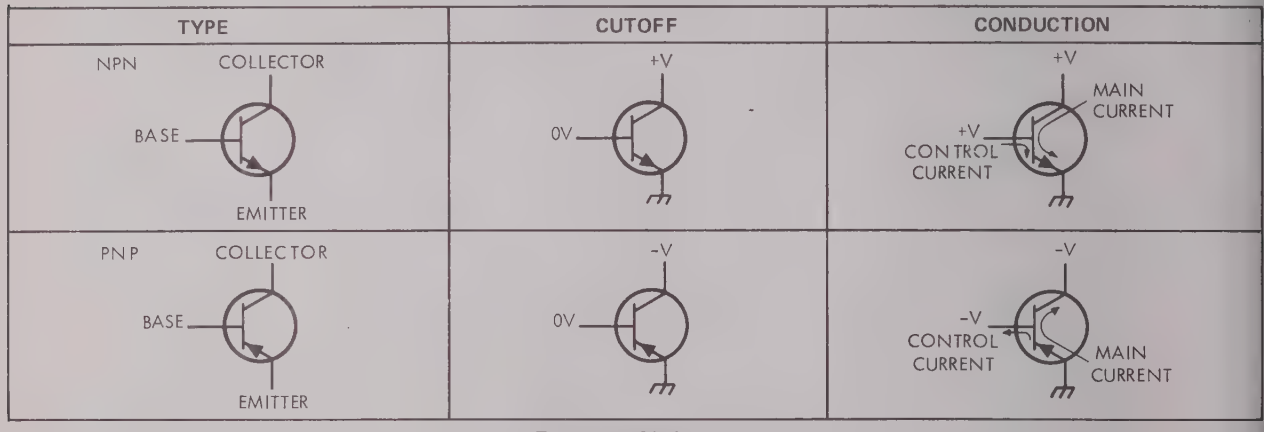
3-7. Transistor Biasing. Standard PNP and NPN symbols and biasing requirements for each transistor type are shown in a, Figure 3-1. If the base-emitter junction is forward-biased, the transistor conducts; the degree of conduction can vary from bare turnon to saturation, depending upon the bias amplitude. If the junction is reverse-biased, the transistor ceases to conduct. During conduction, the collector current varies with the base-emitter bias. For example, a germanium transistor that is forward-biased may have 200-to-300 millivolts across the base-emitter junction and a collector current in the range of 1-to-10 milliamperes; a junction voltage of 400-to-500 millivolts will typically increase the collector current to a range of perhaps 10-to-100 milliamperes. The forward-bias voltage for silicon transistors is about twice that for germanium types – about 500-to-600 millivolts when collector current is low and about 800-to-900 millivolts when collector current is high.

NOTE

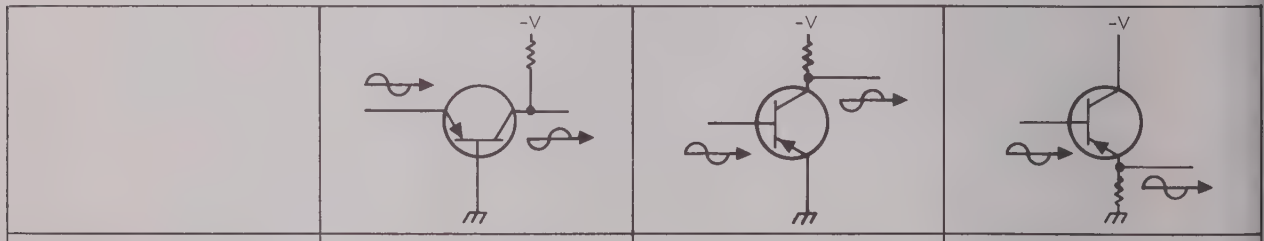
When measuring voltage across the base-emitter junction, do not connect voltmeter probes between the base and emitter – there may be sufficient loop current to damage the transistor. Instead, measure between each element and a common point, such as chassis ground.

3-8. Transistor Characteristics. Common causes of transistor failure are excessive currents that cause internal "shorts" and "opens". In out-of-circuit and in-circuit testing, the most important consideration is the base-emitter junction.

3-9. Simplified versions of three basis transistor circuits and their characteristics are shown in b, Figure 3-1. When troubleshooting a transistor stage, measure the voltage between the base and emitter to determine if this junction is biased for conduction (forward-biased). If the junction is forward-biased, check for "switch action" by putting a short-circuit between base and emitter; observe collector voltage. The short circuit eliminates base-emitter bias which should cutoff the transistor and cause the collector voltage to approach that of the supply. Any difference between the two voltages is due to leakage current within the transistor. In general, the smaller this current – the better the transistor.



a. Transistor Biasing



CHARACTERISTIC	COMMON BASE	COMMON EMITTER	COMMON COLLECTOR (Emitter Follower)
Input Impedence	30Ω to 50Ω	500Ω to 1500Ω	20KΩ to 500KΩ
Output Impedence	300KΩ to 500KΩ	30KΩ to 50KΩ	50Ω to 1000Ω
Voltage Gain	500 to 1500	300 to 1000	1
Current Gain	1	25 to 50	25 to 50
Power Gain	20dB to 30dB	25dB to 40dB	10dB to 20dB

b. Amplifier Characteristics

Figure 3-1. Basic Transistor Operation

e collector voltage does not change at all, the transistor either an emitter-collector short-circuit or an emitter-bias -circuit.

). Field Effect Transistor (FET). Field effect transistors Figure 3-2) have three terminals; source, drain, and , which correspond in function to emitter, collector, and of junction transistors. Figure 3-2 shows the schematic ol and biasing for N channel and P channel field effect sistors.

l. Troubleshooting Transistors.

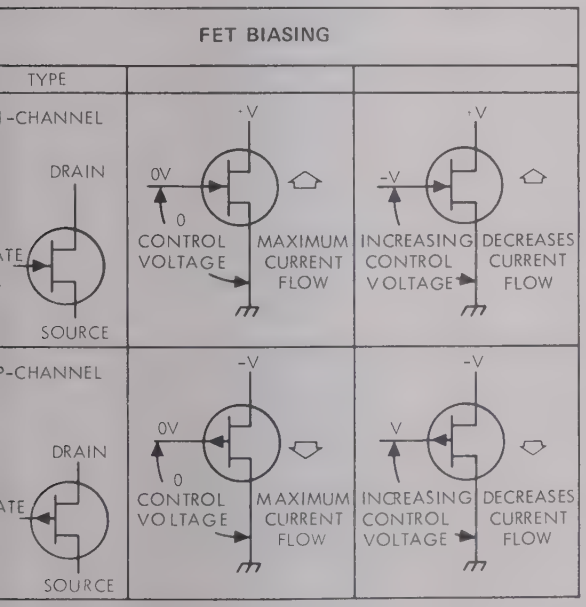
CAUTION

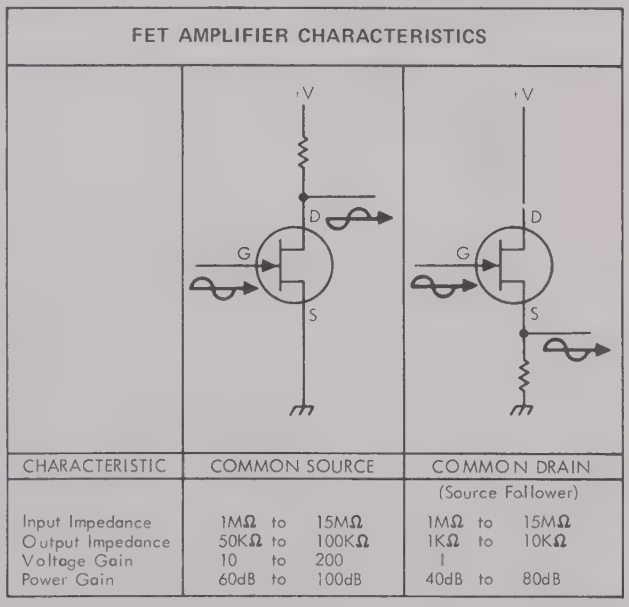
Most ohmmeters can supply enough voltage or current to damage a transistor. Before making resistance measurements on any transistor, check the open-circuit voltage and the short-circuit current outputs ON THE RANGE TO BE USED. For component safety, the voltage should not exceed 1.5 volts and the current should not exceed 3 milliamperes. Table 3-2 shows safe resistance ranges for some common ohmmeters.

3-12. The presence of internal-shorts or open-circuits can be detected in most transistors by simple resistance measurements. Table 3-3 shows transistor types, ohmmeter connections, and typical resistance values. To assist in element identification, examples of transistor and diode markings are shown in Figure 3-3.

3-13. Diode Regulator. Regulated voltages are frequently provided by breakdown diodes. Of the breakdown types, the avalanche and Zener diodes are most commonly used. All these diodes are similar; the main difference is current and voltage ratings. When used as regulators, the diodes are connected in the direction of minimum current, that is, the cathode to the positive source and the anode to the negative source. Typical connections for both positive and negative voltage sources are shown in Figure 3-4. Also shown in Figure 3-4 is a typical regulation window for a 6-volt Zener. When operated on the flat portion of the curve, the diode is an excellent regulator – for a small change in current, there is virtually no change in voltage.

3-14. Voltage Reference. In applications that require a reference-or-regulated voltage of small magnitude, a forward-biased silicon diode is sometime used. A typical circuit is shown in Figure 3-5. When saturated, the voltage across the diode is somewhere between 600-and-800 millivolts.





CHARACTERISTIC	COMMON SOURCE	COMMON DRAIN (Source Follower)
Input Impedance	1MΩ to 15MΩ	1MΩ to 15MΩ
Output Impedance	50KΩ to 100KΩ	1KΩ to 10KΩ
Voltage Gain	10 to 200	1
Power Gain	60dB to 100dB	40dB to 80dB

Figure 3-2. Operation of Field Effect Transistors

TABLE 3-2. SAFE RESISTANCE RANGES FOR SOME COMMON OHMMETERS

Ohmmeter	Range(s)	Open Circuit Voltage	Short Circuit Current	Lead Color	Lead Polarity
HP 412A HP 427A	R x 1K R x 10K R x 100K R x 1M R x 10M	1.0V 1.0V 1.0V 1.0V 1.0V	1 mA 100μA 10μA 1μA 0.1μA	Red Black	+ -
HP 410C	R x 1K R x 10K R x 100K R x 1M R x 10M	1.3V 1.3V 1.3V 1.3V 1.3V	0.57 mA 57μA 5.7μA 0.5μA 0.05μA	Red Black	+ -
HP 410B	R x 100 R x 1K R x 10K R x 100K R x 1M	1.1V 1.1V 1.1V 1.1V 1.1V	1.1 mA 110μA 11μA 1.1μA 0.11μA	Black Red	+ -
Simpson 260	R x 100	1.5V	1 mA	Red Black	+ -
Simpson 269	R x 1K	1.5V	0.82 mA	Black Red	+ -
Triplett 630	R x 100 R x 1K	1.5V 1.5V	3.25 mA 325μA	Varies with Serial Number	
Triplett 310	R x 10 R x 100	1.5V 1.5V	750μA 75μA		

TABLE 3-3. OUT-OF-CIRCUIT TRANSISTOR TESTING

Transistor Type		Connect Ohmmeter		Measure Resistance (ohms)
		Positive lead to	Negative lead to	
PNP Germanium	Small Signal	emitter	base	200 to 250
		emitter	collector	10K to 100K
	Power	emitter	base	30 to 50
		emitter	collector	several hundred
PNP Silicon	Small Signal	emitter	base	10K to 100K
		emitter	collector	very high (might read open)
NPN Silicon	Small Signal	base	emitter	1K to 3K
		collector	emitter	very high (might read open)
	Power	base	emitter	200 to 1000
		collector	emitter	high, often greater than 1 Mego

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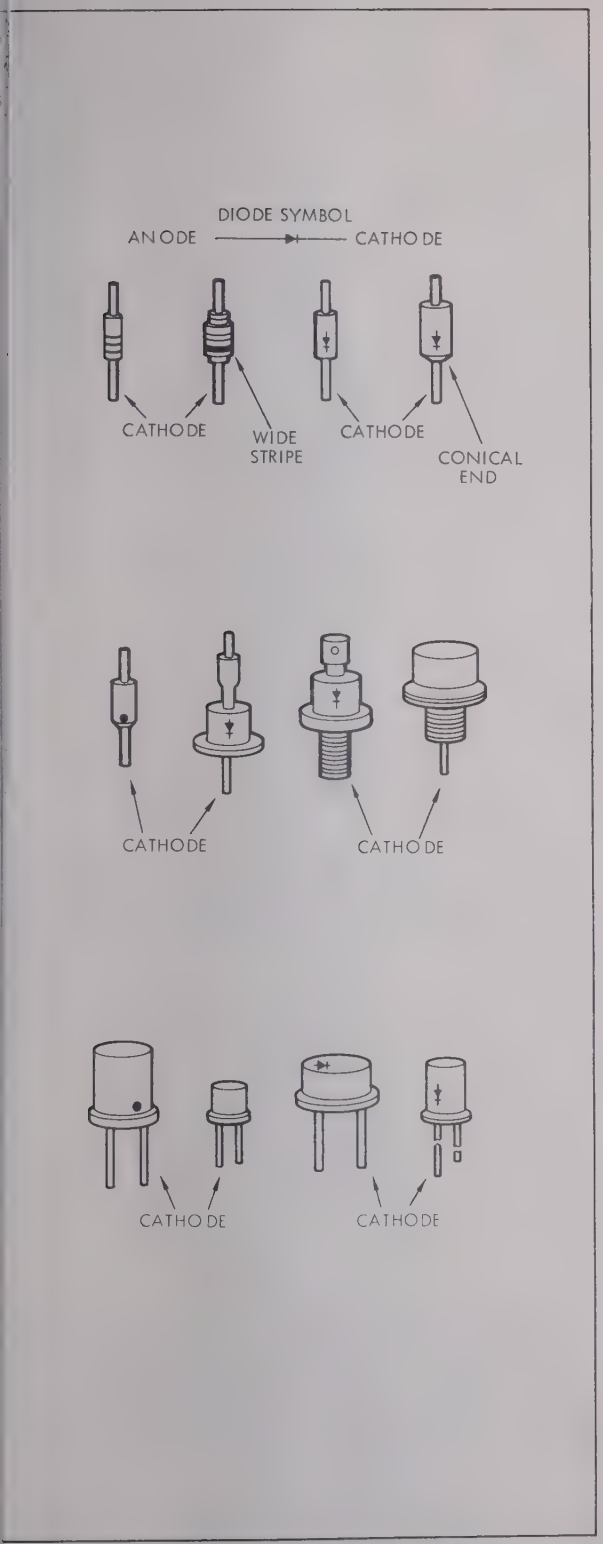


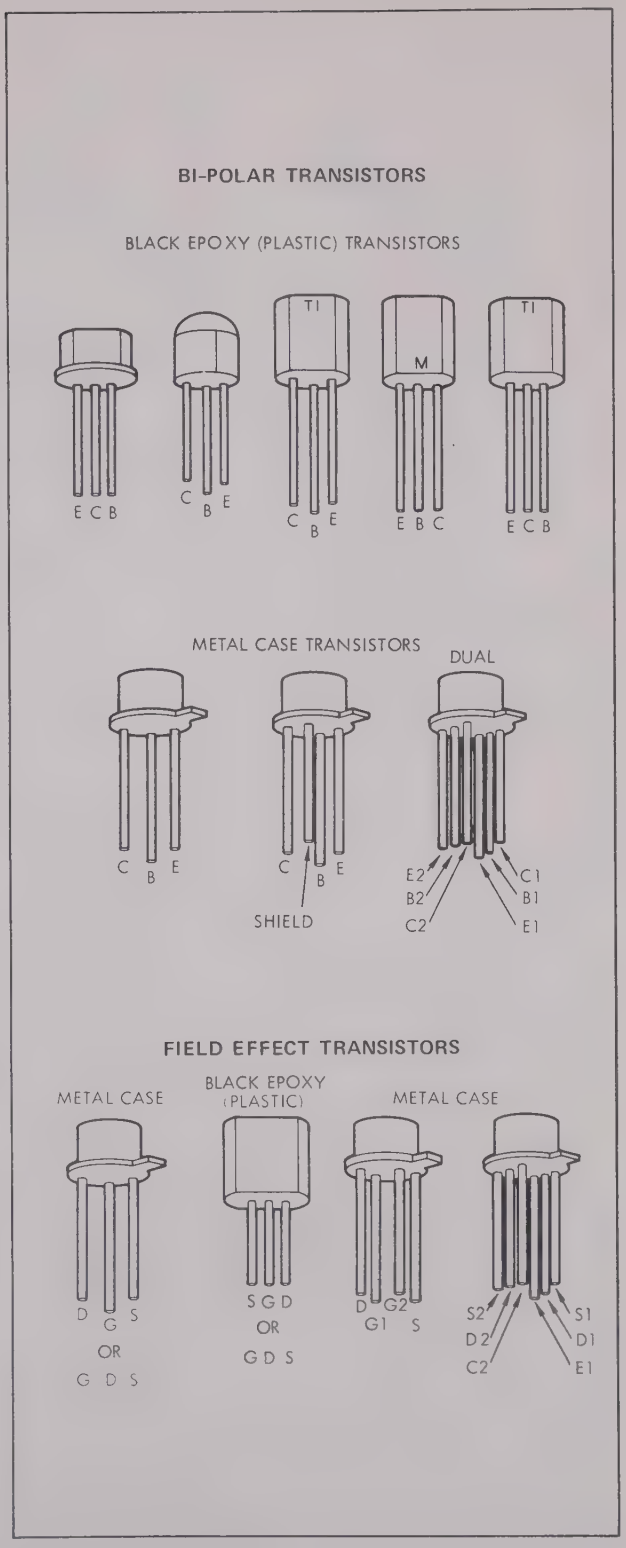


Figure 3-3. Examples of Diode and Transistor Marking Methods

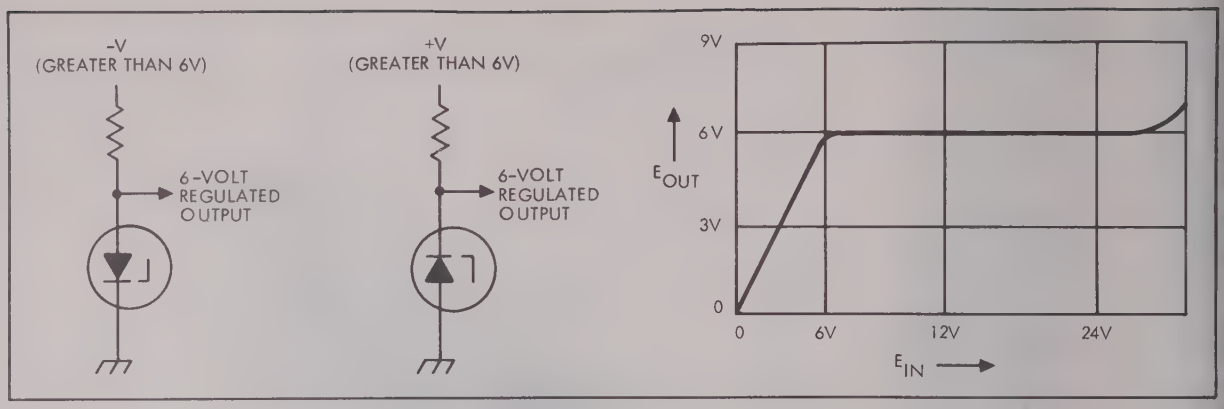
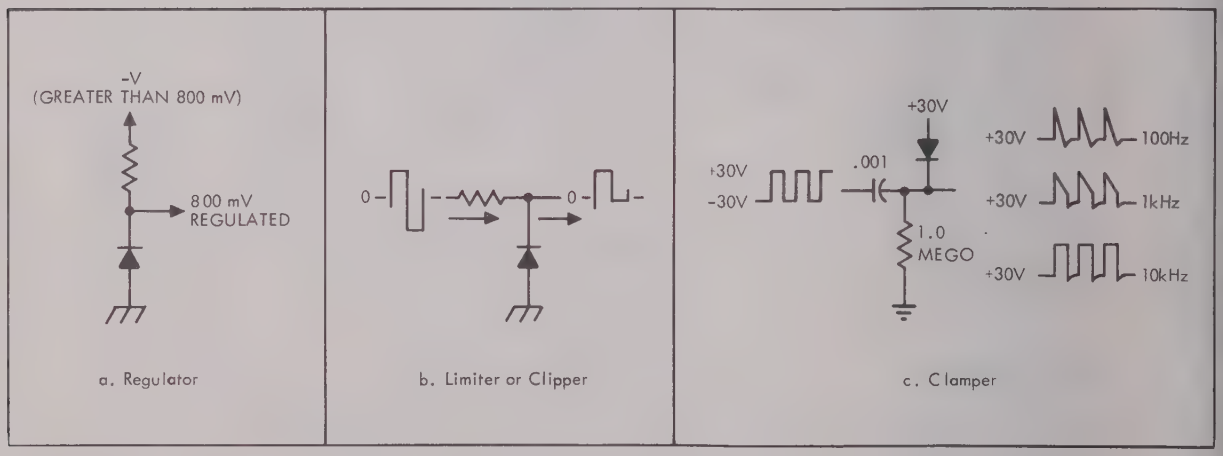


Figure 3-4. Connections for and Characteristics of Zener Diodes



a. Regulator

b. Limiter or Clipper

c. Clamper

Figure 3-5. Basic Diode Circuits

3-15. Diode Limiter or Clipper. This diode circuit removes positive or negative peaks from a waveform. It is frequently used as a waveform shaper and sometimes as a protective device to prevent damage from excessive voltages. A typical circuit is shown in b of Figure 3-5. During the positive half-cycle, the diode is reverse-biased and does not conduct; thus, the positive part of the waveform appears in the output. The diode is forward-biased during the negative half-cycle. Accordingly, the negative output is restricted to the voltage drop across the diode — for silicon types, this is somewhere between 600-and-800 millivolts and, for germanium types, it is somewhere between 150-and-350 millivolts.

3-16. Diode Clamp. The clamper establishes the positive or negative limit of a waveform at a particular dc reference level. The clamper shown in c of Figure 3-5 provides a baseline of about +30 volts. Because of the RC time constant, the circuit is frequency sensitive. At low frequencies, the output is a positive pulse referenced to the +30 volt baseline. As the input frequency is increased, the baseline reference remains the same but the shape of the output signal approaches that of the input squarewave.

3-17. ETCHED CIRCUIT REPAIR

3-18. Etched circuit boards are of the plated-through type consisting of metallic conductors bonded to both sides of an insulating material. Since the metallic conductors extend all the way through the component mounting holes, soldering can be done from either side of the board with equally good results. Recommended tools and materials are listed in Table 3-4. Some general recommendations and precautions are given below.

a. Avoid unnecessary component substitution; damage to the circuit board and/or adjacent components may result.

b. Do not use a high-power soldering iron or gun. Excessive heat may lift a conductor; also, the board may be damaged.

TABLE 3-4. ETCHED CIRCUIT SOLDERING EQUIPMENT

ITEM	USE	SPECIFICATION	ITEM RECOMMENDED
Soldering tool*	Soldering Unsoldering	Wattage rating: 47-1/2 to 56-1/2 Tip Temperature: 850° to 900°	Ungar #776 Handle with Ungar #4037 Heating Unit
Soldering tip*	Soldering Unsoldering	Shape: pointed	Ungar #PL111
De-soldering aid	To remove molten solder from connection	Suction device	Soldapullt by Edsyn Co. Arleta, California
Resin (flux) solvent	Remove excess flux from soldered area before application of protective coating	Must not dissolve etched circuit base board material or conductor bonding agent.	Freon Acetone Lacquer Thinner Isopropyl Alcohol (100% dry)
Solder	Component replacement Circuit board repair Wiring	Resin (flux) core, high tin content (60/40 tin/lead), 18 gauge (SWG) preferred	
Protective Coating	Contamination, corrosion protection	Good electrical insulation, corrosion-prevention properties	Krylon** #1302 Humiseal Protective Coating, Type 1B12 by Columbia Technical Corp., Woodside 77, New York

*For general purpose work, use Ungar #1237 Heating Unit (37.5W, tip temperature of 750-800°) and Ungar #PL113 1 8" chisel tip.

**Krylon, Inc., Norristown, Pennsylvania

c. Use a suction device or wooden toothpick to remove der from component mounting holes. Do not use a sharp tal object such as an awl or twist drill to remove solder; plated-through conductor can be permanently damaged by h procedures.

d. After soldering, remove excess flux from the soldered as and apply a protective coating to prevent contamination d corrosion.

9. A broken or burned section of conductor can be aired by bridging the damaged section with a length of ed copper wire. Allow adequate overlap and remove any nish from etched conductor before soldering wire into place.

0. COMPONENT REPLACEMENT

NOTE

Resistors, capacitors, and other components that mount in a similar fashion can be replaced without removing old leads from the mounting holes. Snip leads near body of defective component; remove component and straighten old leads. Wrap old and new leads; solder connection and clip off excess wire. If defective component must be unsoldered (Table 3-4), remove solder from mounting holes and position new component the same as old. Do not force leads into mounting holes; sharp leads ends may damage plated-through conductor.

1. Removal and Replacement of Transistors. Transistors made in many different shapes and forms. Sometimes, there is confusion as to which lead is the collector, which is the emitter, and which is the base. Figure 3-3 shows epoxy and metal-case transistors and the means of identifying the leads.

3-22. To remove and replace a transistor, proceed as follows:

a. Do not apply excessive heat; refer to Table 3-4 for recommended desoldering and soldering tools.

b. Use long-nose pliers between transistor and hot soldering iron as a heat sink. The instant solder is melted, use pliers to pull lead free of mounting hole.

c. The leads of a replacement transistor should be about the same length as those of the one removed. After cleaning the holes, mount new transistor same as old. In turn, grasp each lead with the tip of pliers and hold soldering iron against wire lead and metal pad. When solder runs freely, quickly remove pliers and soldering iron and wait for solder to solidify. Do not move or pull on lead until the solder sets; otherwise, an intermittent trouble may result.

3-23. If optimum heat dissipation is required, the transistor must make good thermal contact with the mounting surface. To ensure an acceptable thermal bond, coat both sides of the black insulator with Dow Corning #5, silicone compound or equivalent before fastening transistor to the chassis.

3-24. Removal and Replacement of Diodes. Not all diodes are marked with the standard cathode/anode symbols; some typical variations are shown in Figure 3-3. If there is doubt as to polarity, an ohmmeter can be used to determine which lead connects to the cathode and which connects to

the anode. However, the lead polarity of the ohmmeter must be known; lead polarity of some common ohmmeters are shown in Table 3-2.

NOTE

Removal and replacement procedures for diodes are similar to those used for transistors. Refer to Paragraph 3-21.

3-25. REMOVAL OF ELECTRONIC ASSEMBLIES

3-26. To remove assemblies A1 through A13, first remove top cover of 9515, by removing screws and lifting cover.

3-27. Removal of Assembly A1. Remove two screws from shell of J2 on rear panel. Pull socket and extender A19 through hole in rear panel, from socket on A1. Lift A1 from its socket on Mother Board A15.

3-28. Removal of Assemblies A2 through A4. Lift assembly straight up from its socket on Mother Board A15.

3-29. Removal of Assembly A5. Remove two screws from shell of J1 on rear panel. Pull socket and extender A18 through hole in rear panel from socket on A5. Lift A5 from its socket on Mother Board A15.

3-30. Removal of Assemblies A6 through A13. Lift assembly A6 straight out of its socket on Mother Board A15. A12 and A13 may require rocking a little to release the boards from the thermal conducting grease on the heat sinks. Boards A7 through A11 have heat sinks at one end. They are more easily removed by lifting the heat sink end of the board.

3-31. Removal of Assembly A14. With top and bottom covers removed, remove connector in top of A14; remove one screw at center of connector, to allow this. Remove one screw from bottom of A14. Remove four screws from rear panel, near corners of A14. Slide A14 out of rear panel.

3-32. Removal of A15. The Mother Board, A15, has many wires soldered to E terminals. It is not advisable to attemp removal of A15. In an emergency, remove other assemblies; tag all wire connections before unsoldering; unsolder wires with minimum temperature iron, to prevent burning of boards; remove mounting screws from top and bottom of board; lift A15 out of bottom of inverted 9515.

3-33. Removal of A16. Supply Interface Board, A16, is used only with Avantec YIG oscillator for 4-8 GHz. To remove, tag, then unsolder 3 wires; remove mounting screws; lift out of 9515.

3-34. Removal of A17. The Switch Board, A17, has a number of wires soldered to E Terminals. It is not advisable to attempt removal of A17. In an emergency, with 9515 inverted, tag and unsolder all wires connected to A17; remove mounting screws and RF connectors from YIG oscillator behind it. Remove three screws which hold the front edge of A17. Slide carefully back until switch buttons are out of panel. Tilt and lift out of 9515. Fasten YIG oscillator back in place, temporarily, with two screws.

3-35. Removal of A18. Remove two screws from connector shell of J1 (A18) and slide connector out of rear panel and from connector on A5.

3-36. Removal of A19. Remove two screws from connector shell of J2 (A19) and slide connector out of rear panel and from connector on A1.

3-37. TROUBLESHOOTING TIPS

3-38. RF Components. RF components are nonrepairable in the field; return faulty components to the factory for repair or replacement.

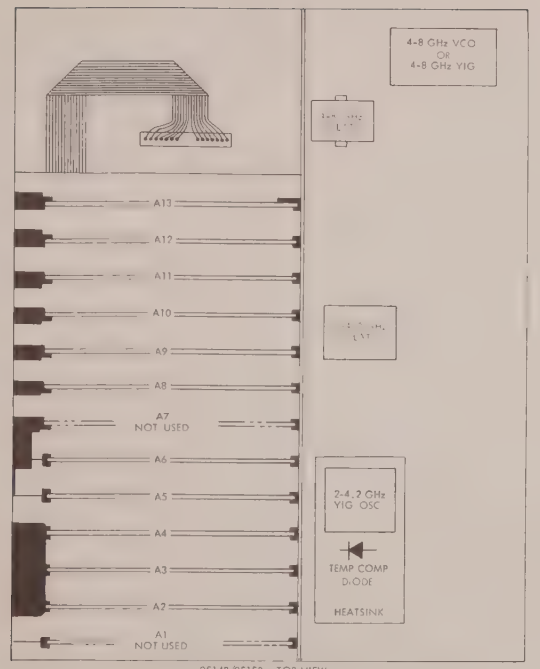
3-39. PNP and NPN Transistors. Conventional PNP or NPN transistors are basically "off" devices and have three operating states:

- OFF – an open switch
- PART WAY ON – bias voltage set for amplification. Transistor can be turned further on or further off.
- SATURATED – behaves like a closed knife switch. Sum or IR drops across emitter collector resistors equals supply voltages.

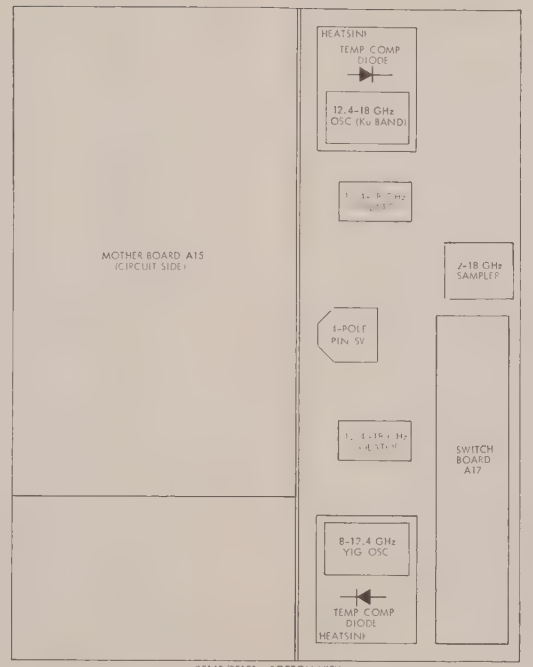
Shorting base to emitter turns off transistor. If transistor does not turn off, it is either shorted or leaky. To measure leakage current, short base to emitter and measure between collector and supply. Leakage current equals the measured voltage divided by whatever resistance appears between collector and supply voltage. The leakage current increases with heat and doubles about every 10°C. For normal silicon transistors, the leakage is never more than several nanoamperes. For germanium transistors, the leakage current may be several microamperes.

3-40. Field Effect Transistors.

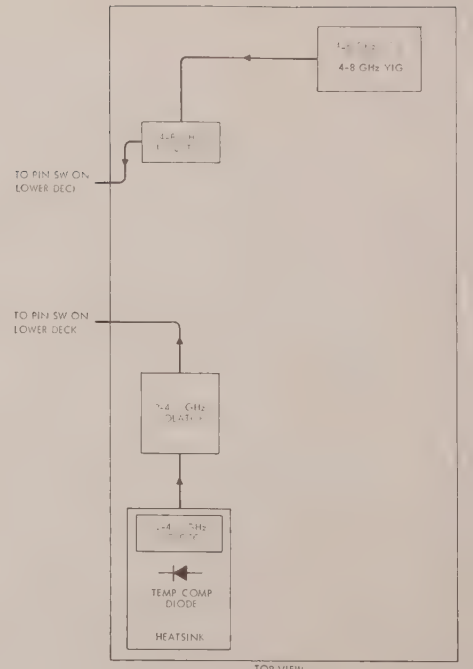
- Unlike PNP and NPN transistors, junction-gate and insulated-gate (non-enhanced) FETs are basically on devices and must be biased off.
- If at all possible, use in-circuit voltages to troubleshoot all FETs.
- External leakage paths such as moisure buildup in soldering fluxes should be closely watched – makes a FET look defective when it is not. If transistor is biased off and leakage is indicated, use a stick-type eraser and thoroughly clean PC board around FET. Recheck leakage current before replacing transistor.



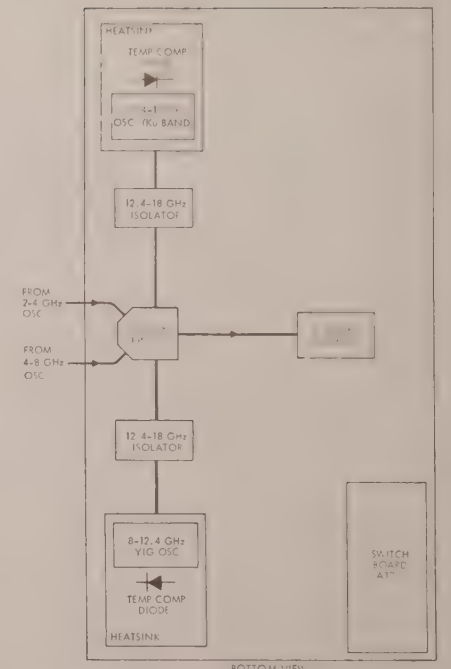
9514B/9515B - TOP VIEW



9514B/9515B - BOTTOM VIEW



TOP VIEW



BOTTOM VIEW

RF DECKS SHOWING MICROWAVE CABLING

This Table is a guide for troubleshooting the 6600/9514B/9515B as a system.

Step No.	Symptom	Test Procedure (TP	Result	Next Procedure
1	No RF output, low RF, RF in only one band.	1. Check power supply regulators	a. Regulators OK.	a. Go to TP 2.
			b. Regulators not proper.	b. Troubleshoot and repair.
		2. Check leveling loop output	a. Leveling loop proper.	a. Go to TP 3.
			b. Leveling loop inoperative.	b. Troubleshoot and repair.
		3. Check YIG and VCO drives	a. One or more YIG's inoperative.	a. Repair or replace.

Step No.	Symptom	Test Procedure (TP)	Result	Next Procedure
2.	No RF output and no band switching after unit is on for awhile. RF returns if unit is switched off then back on. This phenomenon occurs intermittently for no apparent reason.	1. Check F1 fuses on YIG driver A8, A10 and A11.	a. Fuses open.	a. Replace.
			b. Fuses OK.	b. Troubleshoot and repair power supply and regulators per Table 4-1C and 4-1D.
3.	No internal AM or PM modulation.	1. Check leveling loop per Table 4-1J.	a. Leveling loop OK.	a. Troubleshoot 6600 or external PM generator.
			b. Leveling loop defective.	b. Troubleshoot and repair.
4.	No FM modulation.	1. Check FM driver per Table 4-1F.	a. FM modulation inoperative.	a. Troubleshoot and repair.

Step No.	Symptom	Test Procedure (TP)	Result	Next Procedure
5.	Excessive residual FM in all bands.	1. Check YIG and VCO driver per Table 4-1E and 4-1F.	a. Drivers OK.	a. Troubleshoot 6600.
			b. Drivers have excessive FM.	b. Troubleshoot and repair.
6.	No sweep.	1. Check connector board A5 per Table 4-1H.	a. Connector board OK.	a. Troubleshoot 6600.
			b. No ramp from connection board.	b. Troubleshoot and repair A5.
7.	No blanking or sweep stop blanking.	1. Check leveling loop per Table 4-1J.	a. Leveling loop OK.	a. Troubleshoot 6600.
			b. Leveling loop improper.	b. Troubleshoot and repair leveling loop.
8.	Remote leveling function inoperative.	1. Check remote level board A1 per Table 4-1M.		a. Troubleshoot and repair A1.

Figure 3-6. 9514B/9515B Wideband Swept Oscillator – Overall Block Diagram, Block Analysis, System Troubleshooting and General Reference Data (Sheet 1 of 2)

BLOCK ANALYSIS

General. The 6600(A)/9514/9515 combination forms a very wideband sweep-frequency microwave generator. Frequencies from 2-18 GHz are available with linear sweeping over each discrete band. If desired, the generator can also be operated at any fixed frequency within the foregoing range.

The 6600 mainframe supplies sweep voltages, trigger functions, and various modulation input signals. Specific functions of the mainframe are discussed in the 6600 manual.

9514 Controller. As shown in the accompanying block diagram, the controller is a band selector and code converter. The 0 to +10 volt tuning ramp from the mainframe is connected to conversion circuits in the 9515. Modulation signals are connected to the oscillator without change. In remote operation (optional), band selection signals (3-bit binary) from an external computer are changed to digital control signals and sent to the 9515 oscillator unit. RF output level is controlled by a potentiometer (LEVEL CONTROL) mounted on the front panel. Also mounted on the front panel is an UNLEVELLED WHEN LIT indicator driven by control circuits in the oscillator unit – refer to the leveling loop for operation of this indicator.

9515 Oscillator. The 9515 oscillator is a group of microwave oscillators, with leveling circuits, tuning voltage conversion circuits, FM Drivers for the oscillators, and the logic needed to provide various bands of continuously swept frequencies. The Band Control Logic, A6, driven by band selection signals from the 9514, via A5, selects sweep signals and provides timed switching to given continuous RF from one or two oscillators in one (2-18 GHz) band.

All oscillators continuously produce RF power, that is, they are never turned off. The desired frequency range, as determined by the operator, is selected by a 4-pole PIN switch. In the leveled mode of operation, the PIN also attenuates the output, via the closed-loop leveling circuits.

The signals which tune the oscillators are converted from the 0 to +10V signal which is produced in the 6600(A). The timing for changing from one oscillator to another during a sweep is also taken from the 0 to +10V sweep supplied by the sweep is also taken from the 0 to +10V sweep supplied by the 6600(A) Hence, switching to a second oscillator occurs precisely as the first oscillator reaches the end of its frequency band and the second oscillator produces the same frequency and sweeps through its band. A delay of approximately 2 ms occurs as the 9515 changes from one oscillator to another. The conversion is accomplished in A6.

The circuits on A6 control the Drivers (A7 through A11) which supply current to the Tuning Coils of the YIG oscillators.

The FM Driver modulates the tuning of each oscillator by feeding current through a coil in the oscillator. Negative feedback provides current directly proportional to FM input voltage. For models using a VTO, the FM input voltage is applied to the tuning voltage circuit to produce a much smaller deviation in frequency.

Output power leveling is provided by the Leveling Circuit, which controls the PIN Switch Attenuator, S1. Inputs for leveling may be either a built in sample detector at the output of the attenuator or an external output sample detector, of either negative or positive polarity, automatically converted, if needed, in the Leveling Circuit. Overall level of RF power is controlled by a bias voltage selected on the 9514 Level Control. Pulse Modulation is provided by signals from A3 to S1, via A4, and the external PIN modulator.

Because of additional power requirements, beyond the normal capabilities of the 6600(A), the 9515 has a built in power converter A12, A13, A14, to change 115/230 volts, to various required voltages.

Heterodyne Circuits. The heterodyne circuits shown in the accompanying block diagram use the 2-4 GHz YIG oscillator to supply sweep frequencies. The maximum frequency used for the oscillator is 4.2 GHz. A fixed frequency oscillator (Y5) operates at 2.2 GHz.

The mixer output is amplified by wideband amplifiers AR1 and AR2, sampled in HY1, and fed to an RF output jack. Leveling of the heterodyne signals is accomplished in PIN switch attenuator S3. Feedback from the sampler in the directional coupler HY1 provides constant output regardless of gain variations in the mixer amplifier circuits.

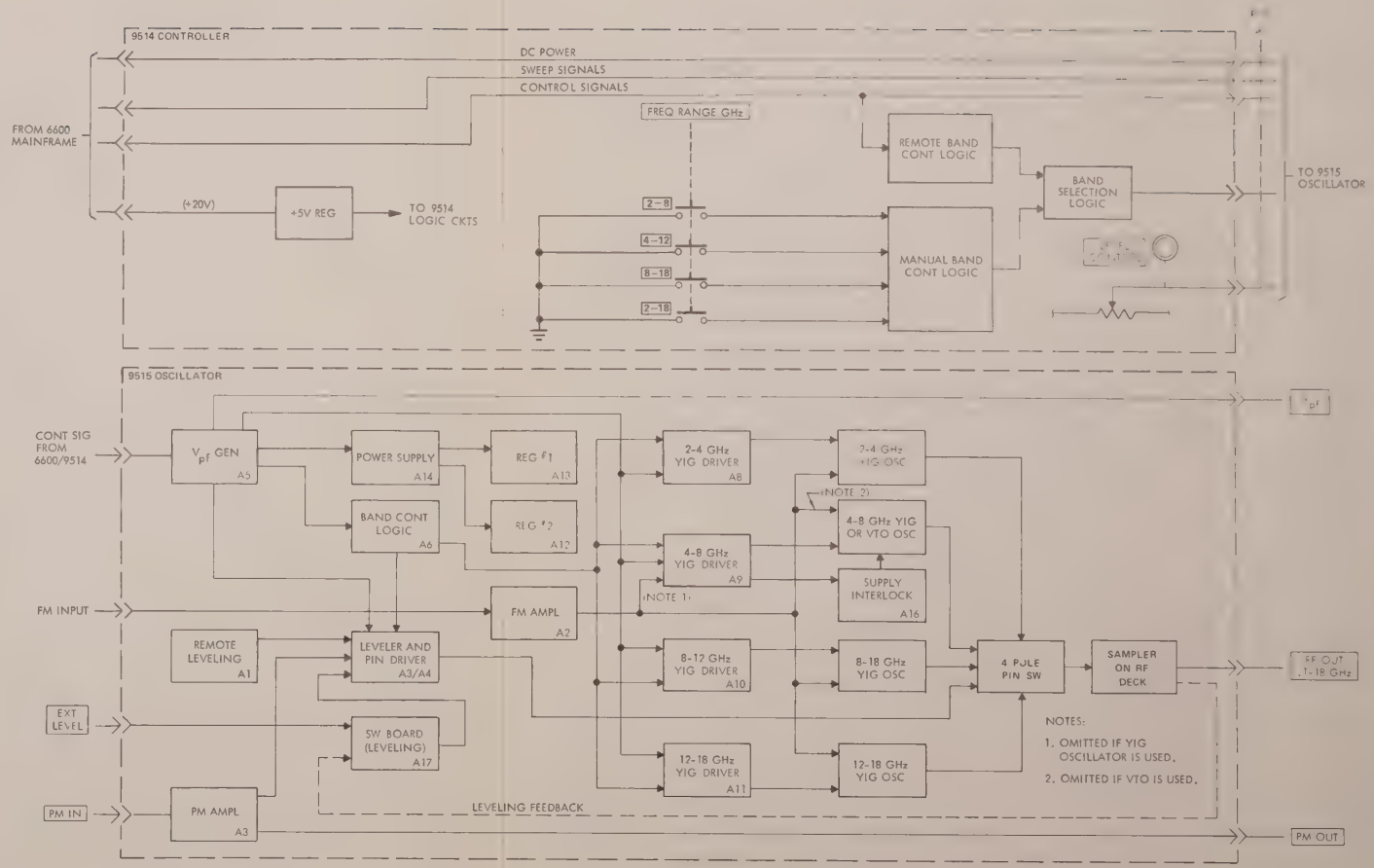
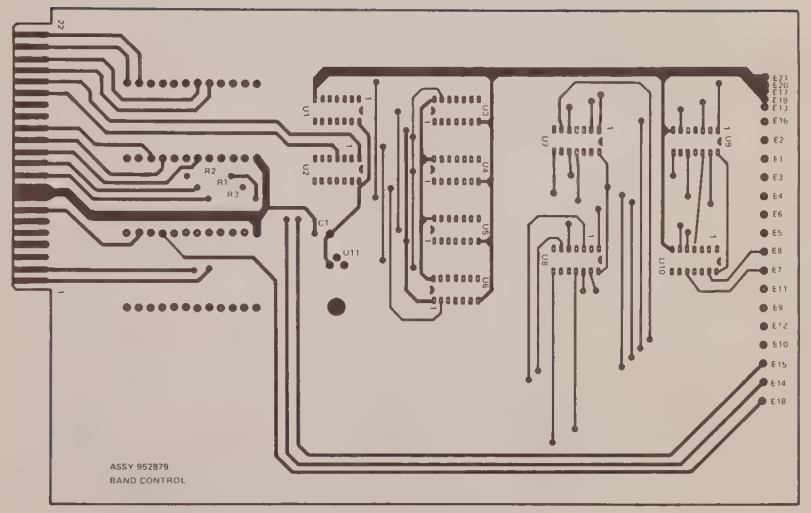


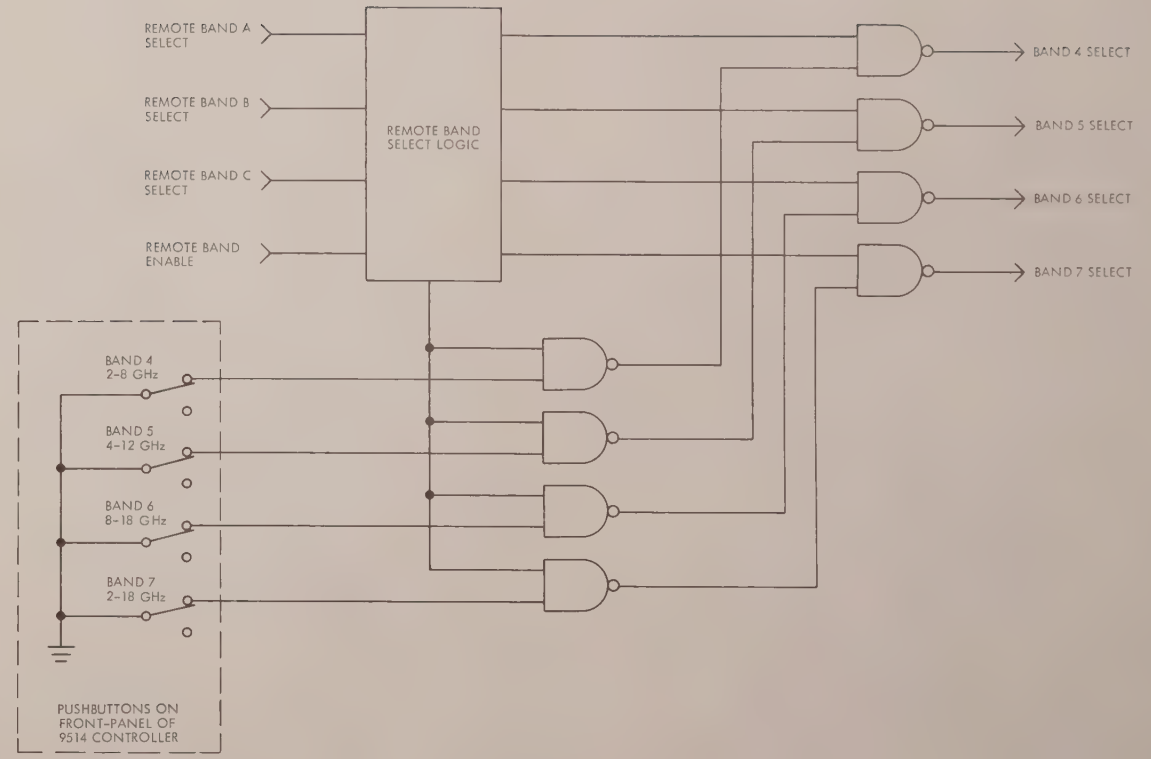
Figure 3-6. 9514B/9515B Wideband Swept Oscillator – Overall Block Diagram, Block Analysis, System Troubleshooting and General Reference Data (Sheet 2 of 2)



COMPONENT SIDE

BLOCK ANALYSIS

The 9514 Controller provides connections between the 6600 and the 9515 for supply voltages, amplitude modulation signals, and tuning voltages (ramps). It also provides band selection signals to the 9515. These signals are derived from push button switches on the 9514 front panel and from binary coded signals received via the 6600.



9514B CONTROLLER - SIMPLIFIED BLOCK DIAGRAM

Figure 3-7. 9514B Controller with Schematic Diagram (106-0812-001), Component Locator (944442, Rev 02), Block/Circuit Analysis, and other Reference Data (Sheet 1 of 2)

CIRCUIT ANALYSIS

The decoding circuits use three types of integrated circuits.

a. Two input NAND gates.

b. Four input NAND gates.

c. Inverting Amplifiers.

The NAND gates have +5V outputs unless all inputs are at +5V, or floating. The output, with all +5 volts inputs, is ground. The inverters have +5 volts output for ground input and ground output for +5 volts input, or a floating input.

Put to assuming that Remote Band is not enabled, the input to terminal 18 is floating. The output of the inverter is ground. This gives a ground input into each of the eight type 5420 decoding NAND gates. Hence the output of each 5420 gate is +5 volts.

The manual control inverter which follows the Band Enable inverter has a ground input, so its output to each of the eight manual switch gates is +5 volts. If a Band Selector switch is pushed open, the input to its control gate floats, and since the other input if +5 volts from the manual control inverter, the manual control gate output is ground. All other manual control gate outputs are +5 volts, since the switch inputs to them are at ground.

This makes all of the inputs to the Band Control gates (U7 and U8) +5 volts except for the ground signal from the Manual Control gate for the open switch. Consequently, all output band select signals are at ground except for the signal for the open switch; this output is +5 volts, which is connected to the 9515 as Band Select.

For remote operation, the input to the remote band enable inverter is grounded. The inverter output is +5 volts.

This voltage is applied to one input of each of the 5420 gates. The manual control inverter has a ground output which is applied to each manual control gate. Hence the output of each manual control gate is +5 volts.

There are three remote band select inputs, marked A, B and C; each input goes through an inverter. The output of each band select inverter goes to one input of several 5420 gates. It also goes to the input of an inverter above and to the right of the band select inverter. The output of the second inverter goes to one of the inputs of each of the 5420 gates which is not connected to the corresponding band select inverter output.

With inputs to A, B and C all grounded, and with Remote Band Enable grounded, the 5420 gates are driven by +5 volts signals from Remote Band Enable inverter and from each band select inverter. Each second inverter has a ground output. Tracing signals through the 5420 gate for Band 0 (top band on the schematic) there is ground on pin 13, ground on pin 12, ground on pin 10 and +5 volts on pin 9. The 5420 output on pin 8 is +5 volts, so both inputs to the Band Control gate for Band 0 are +5 volts. The signal on the Band 0 line is ground, which means not selected.

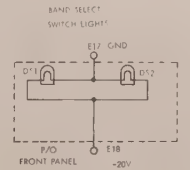
Going through the other gate connections, it will be found that each 5420 gate has at least one ground input. Hence its output is positive and the band selection output is ground.

This is true until Band 7 is reached. For the 5420 gate for Band 7, pin 5 is +5 volts, from the Remote Band Enable inverter. Pin 4 is +5 volts from the Band C inverter. Pin 2 is +5 volts from the Band B inverter. Pin 1 is +5 volts from the Band A inverter. Hence the 5420 gate output is GND and the Band 7 output is +5 volts, indicating selection of Band 7, as shown by +5 volts on pin 29 of connector J1.

It will be seen the selection of bands follow the Remote Select Logic Table on the schematic where a 1 input means +5 volts, and an 0 input means ground potential.

Potentiometer R4 controls the level at which the 9515 holds RF output power.

Integrated circuit U11 is a regulator which reduces the available +20 volts to a well regulated +5 volts which is supplied to each of the other integrated circuits in the 9514.



NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL CAPACITORS IN MICROFARADS
2. "E" TERMINALS ARE ON MAIN PCB THEY CONNECT TO COMPONENTS NOT ON PCB AS SHOWN WITHIN DOTTED AREAS
3. SCREENED LINES AND TERMINALS NOT USED IN 9514B.

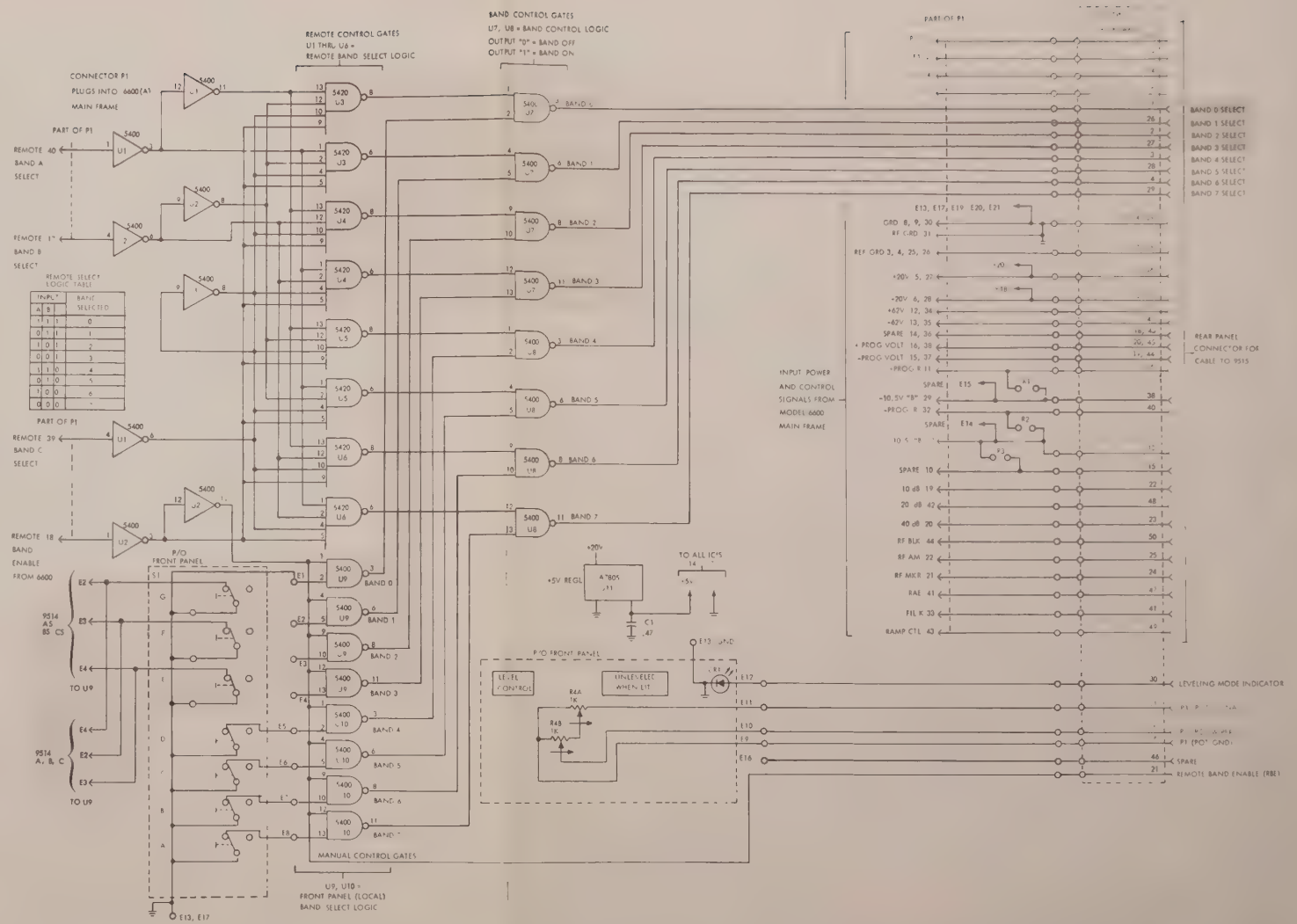


Figure 3-7. 9514B Controller with Schematic Diagram (106-0812-001), Component Locator (944442, Rev 02), Black/Circuit Analysis, and other Reference Data (Sheet 2 of 2)

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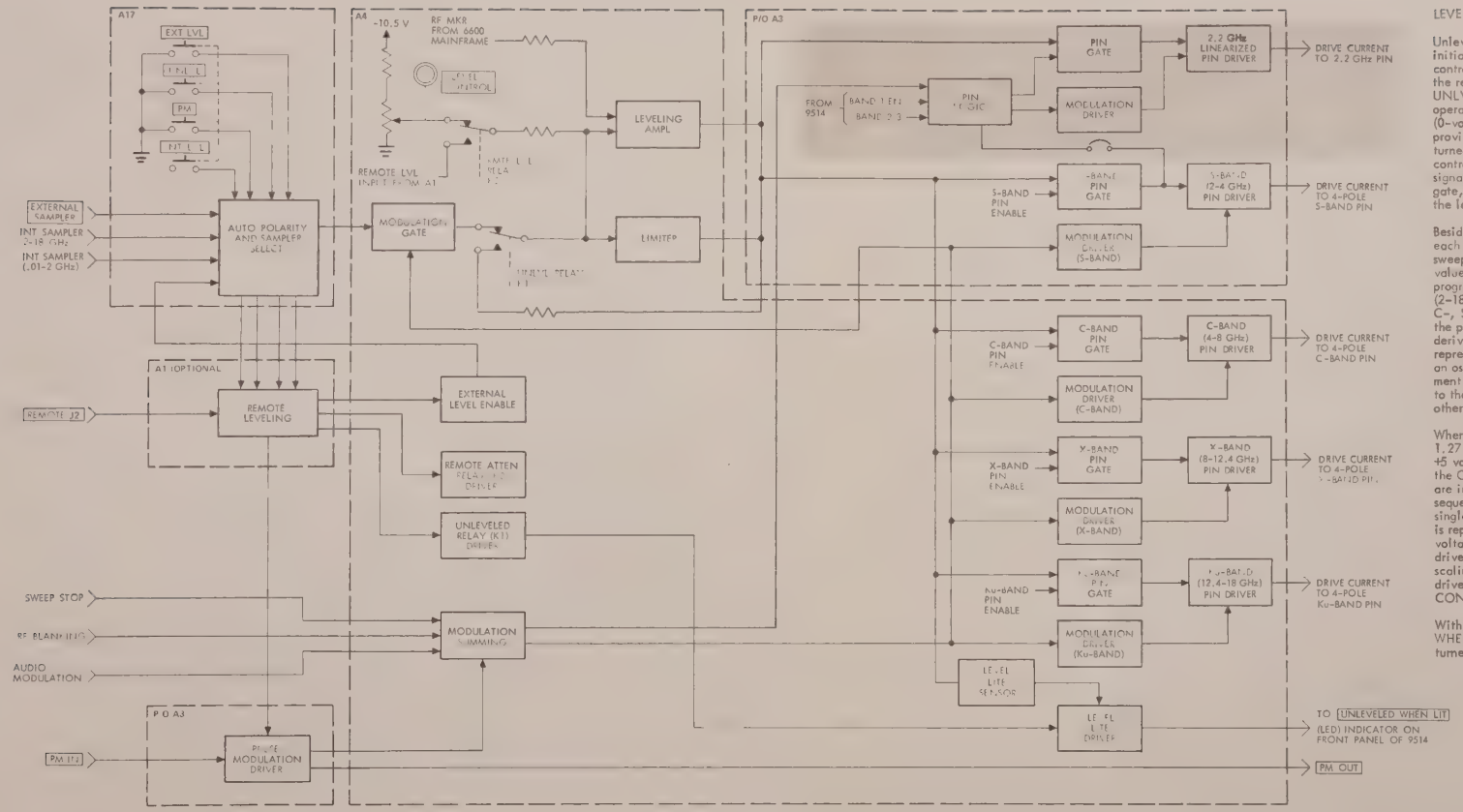


Figure 3-8. 9514B/9515B Leveling Loop with Functional Analysis (Sheet 1 of 2)

LEVELING LOOP - FUNCTIONAL ANALYSIS

Unleveled Operation. The unleveled mode of operation is initiated by pressing the UNLVL pushbutton on the 9514 controller. This action, via the auto polarity/sample select, the remote leveler, and the relay driver circuits, energizes UNLVL relay K1. With K1 energized, the leveling amplifier operates at a fixed gain of four. Accordingly, the dc signal (0-volts/500-millivolts) taken from the LEVEL CONTROL provides an inverted output of 0-volts when the control is turned fully counterclockwise and a +2 volt output when the control is turned fully clockwise. The 0-to-2 volt control signal is applied to the S-band PIN gate, the C-band PIN gate, the X-band PIN gate, the K_u-band PIN gate, and to the level lite sensor.

Besides the control signal, an enable signal is also applied to each of the PIN gates. The enable signal is a function of the sweep-ramp voltage progresses from 0-volts to a maximum value, in full-band sweep the frequency starts at 2 GHz and progressively increases to 18 GHz. Since the overall (2-18 GHz) swept range is divided into four bands, the S-, C-, S-, and K_u-band YIG oscillators must be turned on in the proper sequence. For this purpose, four sets of logic are derived from the tuning ramp; in each set of logic, 0-volts represents an oscillator inhibit, whereas, +5 volts represents an oscillator enable. In full-band sweep, the 2-4 GHz segment is supplied by the S-band YIG; thus, +5 volts is applied to the S-band PIN enable input and 0-volts is applied to all other PIN-enable inputs.

When the top of S-band is reached (4 GHz -- approximately 1.27 volts on the ramp), the S-band oscillator is disabled and +5 volts is applied to the C-band PIN gate enable. Hence, the C-band YIG oscillator is active and all other oscillators are inactive. In the same way, the X-and-K_u bands are sequentially activated and, unless the operator chooses the single-sweep mode of operation, the full-band sweep cycle is repetitive. As each PIN gate is activated, the control voltage (output of leveling amplifier) is applied to the PIN driver associated with the active gate. After appropriate scaling and processing, this voltage is converted to a PIN drive current that yields, for stop-to-stop limits of the LEVEL CONTROL an output amplitude range of approximately 30 dB.

With the output unleveled, the front-panel UNLEVELED WHEN LIT indicator glows red; the LED indicator lamp is turned on by the level-lite driver circuits. In the leveled mode of operation, the lamp turn-on command is either passed or inhibited by the level-lite sensing circuits, depending on fluctuations in the RF output -- refer to leveled operation of the loop.

Leveled Operation. When the INT LVL pushbutton on the controller is pressed, UNLVL relay K1 is deenergized. Under these conditions, a dc voltage proportional to RF output amplitude (Internal Sampler/2-18 GHz) enters the auto polarity/sampler select circuits. This voltage (Figure 3-1) is derived from the sampler which consists of a directional coupler and an RF detector located on the lower microwave deck. Depending upon the detector used, the dc sample can be either polarity and, as shown, it can originate from either of two sources -- the 0.01-2 GHz sampler or the 2-18 GHz sampler. Upon examination, the decisions as to polarity, and which sampler are automatically made by the auto polarity/sample select circuits. If the detector output is negative, the polarity is inverted, if positive, no inversion is required. Thus, a sample voltage of positive polarity is always applied to the modulation gate.

With no inputs from the modulation summing amplifier, the sample voltage is gated straight through and added, at the input of the leveling amplifier, with the dc voltage taken from the LEVEL CONTROL. In the leveled mode of operation, the leveling amplifier furnishes an output voltage to the selected PIN driver which, in turn, produces an RF output from its associated oscillator. This RF output is detected and, as previously indicated, the resulting dc sample is applied as one input to the leveling amplifier. If the output power is too high, the PIN drive is reduced; if the power is too low, the drive is increased. In either case, the loop continually strives to produce a "null" at the input of the leveling amplifier. As long as the input-null conditions are satisfied, the output of the amplifier is a varying dc voltage that is equal-and-opposite to power fluctuations in the RF output. Should the output power be insufficient to produce an input "null", the differential voltage is amplified until the output is clamped at about +2 volts at the limiter. If this happens, the conditions is sensed by the level-lite sensor and the UNLEVELED WHEN LIT indicator is turned on. Generally, the indicator can be extinguished by turning the LEVEL CONTROL slightly counterclockwise -- maximum leveled power is obtained with the control set to the 3-o'clock position.

LEVELING LOOP – TROUBLESHOOTING

Step No.	Symptom	Test Procedure (TP)	Result	Next Procedure
		Note. The following procedures assume that all relevant power supply voltages have been checked and are within tolerance.		
1	With PM pushbutton released, no RF output in any band at any frequency in both leveled and unleveled modes of operation.	1. Select unleveled mode of operation, turn LEVEL CONTROL fully clockwise and check voltage at A4-27A.	a. Voltage is approximately +2V.	a. Go to TP3.
			b. Voltage is approximately 0V.	b. Go to TP2.
		2. Check voltage at A4-26b.	a. Voltage is approximately -0.5V.	a. Replace A4U3.
			b. Voltage is approximately 0V.	b. Troubleshoot LEVEL CONTROL circuits of 9514.
		3. Check voltage at A4-6a.	a. 0V.	a. Go to TP5.
			b. Approximately +5V.	b. Go to TP4.
		4. Check voltage at A4-6b, A4-18b, A4-29a, and A4-22.	a. All voltages +5V.	a. Replace A4U7.
			b. One or more voltages low.	b. Troubleshoot appropriate input circuits.
		5. Check voltage at U7-6.	a. +5V	a. Go to TP6.
			b. 0V	b. Replace U7
		6. Check +1V supply (orange lead of 4-pole PIN switch, located on lower microwave deck).	a. Voltage OK.	a. Replace PIN switch.
			b. No voltage.	b. Troubleshoot +1V supply.
2	RF output present but cannot be internally or externally leveled over specified control range; unleveled operation OK.	1. Check voltage at A17-E9. (Note: RF must be present for this check.)	a. Approximately +50 to 200 mV.	a. Replace Q2, Q3, or K1.
			b. Approximately -50 to -200 mV.	b. Replace A17U3, A17Q1, or A17K3.
			c. No voltage at E9.	c. Go to TP2.
		2. Check voltage at A17E15. (Note: RF output must be present for this check.)	a. Approximately -50 to -200 mV.	a. Replace A17U1 or A17K1.
			b. No voltage.	b. Replace detector in 2-18 GHz sampler.
3	RF output and leveling capability in all but one band.	1. Assuming that oscillator is good (Figure), check PIN-select logic.	a. Logic OK.	a. Go to TP2.
			b. No PIN select.	b. Troubleshoot appropriate circuits on logic board A6 (Figure).
		2. Check PIN drivers and associated circuits. PIN-drive output is approximately +3V (RF Off) and -3V (RF On). (Note: S-band/2-4 GHz circuits are located on board A3.)	a. PIN drive OK.	a. Go to TP3.
			b. Always +3V.	b. Check modulation summing circuits; replace defective components.
			c. Always -3V.	c. Check PIN driver operational amplifier and associated circuits; replace defective components.
4	Internal-and-External PM circuits inoperative.	Troubleshoot PM driver on A3.		
5	No AM.	Troubleshoot 6600.		
6	No sweep stop signal.	Troubleshoot logic board A6.		
7	No blanking or marker signals applied to leveling loop.	Troubleshoot 6600 mainframe.		
8	No external leveling capability.	Check detector output of external sampler – should be about 740 mV.	a. Detector OK.	a. Replace A17K1 or A17R2.
			b. Bad detector.	b. Replace.

Remote Leveling. When the EXT LVL pushbutton is pressed and an appropriate sampler is connected to the EXTERNAL SAMPLER input, the remote leveling mode is initiated. In this mode of operation, the LEVEL CONTROL on the 9514 can be used to set the output power level or remote leveling board A1 (optional) can be programmed, via the input connector, to energize remote LVL relay K2. With K2 energized, an external "level control" can be used.

Special-Function Operation. In the leveled mode of operation, RF On/Off decisions are made via the modulation gate. During band changeovers, the sweep stop signal is present and, if selected by the operator, RF blanking occurs during retrace; for either condition, RF is turned off. The modulation summing output is applied to the modulation gate which does two things – it inhibits the dc sample and also provides a pseudo voltage that turns the leveling amplifier off. In effect, the leveling amplifier is fooled into thinking that no output is required to satisfy the loop; thus, when the pseudo voltage is replaced by the true sample, there is no appreciable overshoot in the RF output. In the AM and PM modes, the operation is exactly the same, except the RF On/Off conditions are, respectively, a function of the presence-or-absence of the modulating voltage.

In the unleveled mode, the modulation gate has no effect; however, the RF output is still turned on-or-off. This is implemented by the modulation drivers associated with each PIN. During the "RF-Off" period, the PIN drivers are saturated; thus, no overshoot is possible when the output is restored.

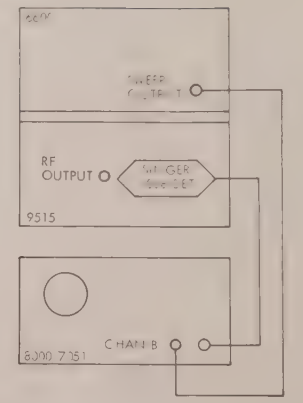
If selected by the operator, M1, M2, and F_o markers are applied to the non-inverted input of the leveling amplifier. Since each marker produces a differential voltage at the amplifier input, the result is a "dip" in the RF output at the marker frequency. Thus, in either the leveled or unleveled modes of operation, the operator can frequency-identify any perturbation in the swept-output waveform.

LEVELING LOOP ADJUSTMENTS

Description:

- A4R17 – to obtain optimum leveled power in the leveled mode of operation.
- A4R20 – to obtain an output control range equal to or greater than 10 dB from minimum-to-maximum leveled power.
- A4R31 – to obtain maximum unleveled power in the unleveled mode of operation.

TEST SETUP:



PROCEDURES:

1. Connect equipment as shown in the test setup and calibrate detector per instructions in 8000/7051 manual.
2. Set network analyzer for 5 dB per division and set sweeper controls as follows:
   - Select full-band sweep and 100-millisecond sweeptime.
   - Press 2-18 GHz pushbutton on the 9514 and LEVELING INT pushbutton on the 9515.
3. Set front-panel LEVEL CONTROL to 3 o'clock position and adjust leveled gain resistor A4R17 until UNLEVELED WHEN LIT indicator just barely extinguishes.
4. Turn LEVEL CONTROL to 9 o'clock position and adjust offset resistor A4R20 for 10 dB down from maximum level obtained in step 3. (Note: The gain and offset adjustments interact, so repeat steps 3 and 4 to optimize both adjustments.)
5. Press UNLVL pushbutton on 9515 and turn LEVEL CONTROL fully clockwise. Adjust unleveled gain resistor A4R31 until RF output starts to decrease – then back off 1-to-1-1/2 turns.

Figure 3-8. 9514B/9515B Leveling Loop with Functional Analysis (Sheet 2 of 2)

CIRCUIT ANALYSIS – A4 BOARD

Functional Overview. Whereas the S-band PIN driver is located on PM and level board A3, the C-, X-, and K_u-band PIN drivers are located on leveling board A4. Each of the PIN driver circuits require three inputs – one from the modulator summing circuits, and one from the band-enable logic. The first two signals are derived on board A4; the band-enable signal is derived on logic board A6. As shown in the overall block diagram of the leveling loop, all of the PIN drivers are identical and, since the S-band circuits have been described, they are not repeated. All other circuits functions of A4 are described in the following paragraphs.

Leveling Amplifier. Leveling amplifier U3 receives a 0 to -500 millivolt input from the front-panel LEVEL CONTROL, located on the 9514 controller. The level-control signal enters at pin 26 and is applied, via the deenergized contacts of remote-level relay K2 and leveled-gain resistor R17, to the inverting input of U3. For these input conditions, gain resistor R17 and offset resistor R20 provide a leveled output range of 10 dB. The RF output is continually sampled and this voltage is applied to the source of sampler switch Q2. If no "RF OFF" condition exists (refer to Modulation Summing), the level at U7-6 is HI; thus, Q3 is saturated and the source-drain impedance of Q2 is essentially a short-circuit. Accordingly, the sampler output is applied to the inverting input of U3, via the deenergized contacts of unleveled relay K1. The difference between the fixed "level-control" voltage and the variable "sample" voltage is amplified by U3 and, since the two voltages are opposite in polarity, a "null" is produced at the summing point (U3-2).

If there is insufficient power from the oscillator to produce an input "null", the output voltage at U3-6 attempts to rise and increase the PIN current. To prevent a runaway condition, the output of leveling amplifier U3 is limited by Q4/Q5. Should the amplifier output exceed the leveled limit of +2 volts, summing point U3-2 is connected to the negative supply via the low series-impedance of the two limiter transistors; thus, the output is held at just above +2 volts regardless of the input differential.

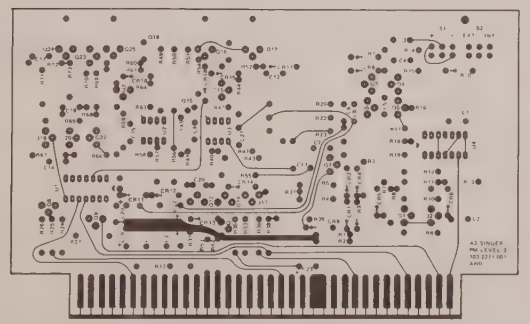
As the limiting threshold is reached, the output at U3-6 is sufficiently positive to trigger level-lite sensor Q2/Q10. Quiescently, Q9 is turned on and Q10 is off; however, if the output of U3 exceeds +2 volts, these conditions are reversed, that is, Q10 saturates and Q9 is turned off. With Q10 saturated, LED driver Q11 is likewise saturated and +20 volts is applied via R47 to the front-panel UNLEVELED WHEN LIT indicator and the light glows red. If the output is returned to a leveled condition by turning the LEVEL CONTROL counterclockwise or by tuning to a frequency where the oscillator output is sufficiently high to produce an input "null" at the selected power level, the voltage at U3-6 will return to its normal control range of 0 to +2 volts. Accordingly, the amplifier output is no longer limited and the UNLEVELED WHEN LIT indicator will extinguish.

In the unleveled mode of operation, a HI logic level (approximately +5 volts) enters the A4 board at pin 35a. The output at U8-10 goes HI and relay driver Q8 saturates and energizes relay K1. Simultaneously, LED driver Q11 saturates and the UNLEVELED WHEN LIT indicator glows. With K1 energized, the sampler is disconnected from the leveling amplifier and U3 operates at a fixed gain of four; unleveled gain resistor R51 is adjusted to provide this gain figure. In the unleveled mode of operation, the LEVEL CONTROL provides an output-amplitude range of approximately 30 dB.

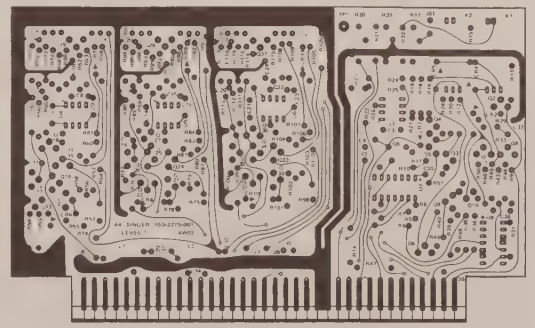
Modulation Summing. Output RF is interrupted in either of four ways – sweep stop, blanking-during retrace, amplitude modulation, or pulse modulation. If any one of these signals is active, a ground appears, respectively, at pins 18b, 22a/b, 6b, or 29a. With a LO at either of pins U7-9, U7-10, U7-12, or U7-13, the output at U7-8 is HI and a LO appears at U7-6. The output at U7-6 is applied to each of the four PIN drivers and to sample switch Q3; hence, the sampler input is inhibited and all PIN drivers are turned off.

Remote Leveling. The remote leveling function (optional A1 board) is initiated by pressing the EXT LVL pushbutton; this action produces a LO at A4-18a which, in turn, produces a HI at the base of relay driver Q6. Hence, remote leveled relay K2 energizes and leveling amplifier U3 is now connected to a remote "LEVEL CONTROL" via pin 33a.

External Sampler. If an external sampler is used and the LEVELING EXT pushbutton is pressed, a LO appears at A4-34a (input) and a HI appears at A4-33b (output). The output is routed to switchboard A17/E17 where it energizes external sampling relay K1. With A17K1 energized, the output of leveling amplifier A4U3 can be controlled by either the front-panel LEVEL CONTROL or from a remote leveling control – refer to preceding paragraph.



COMPONENT SIDE



COMPONENT SIDE

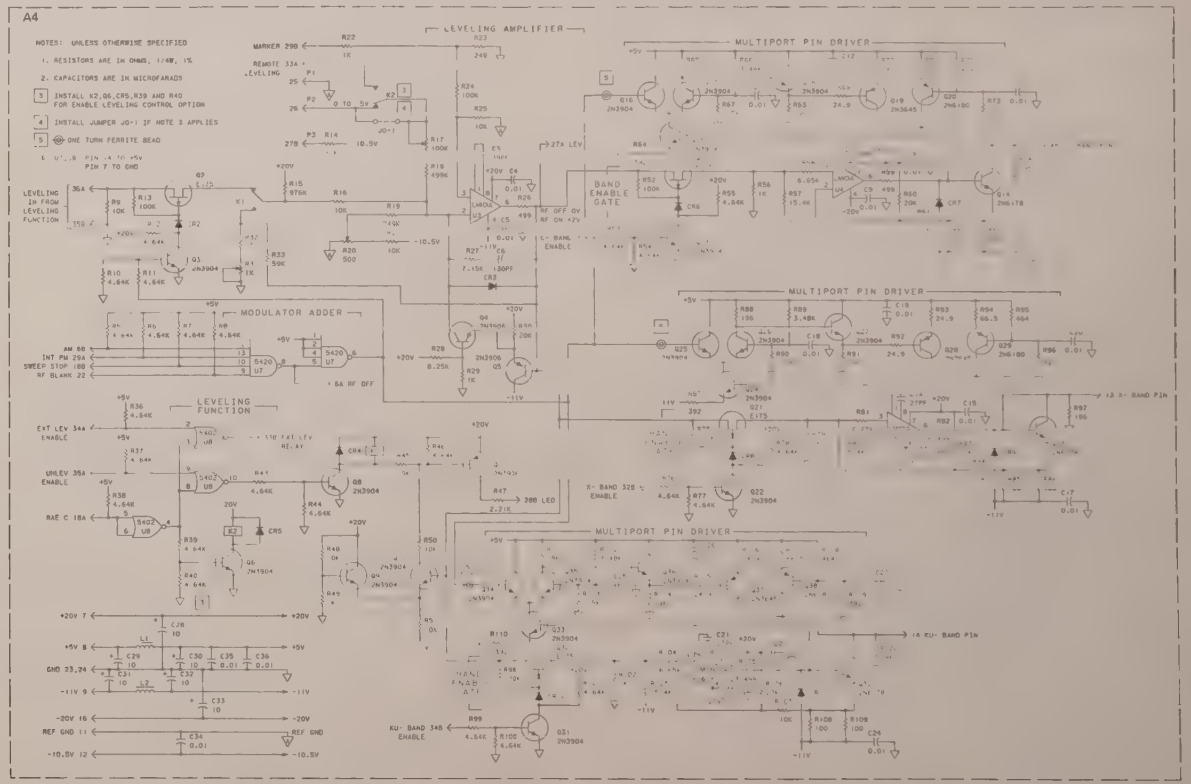
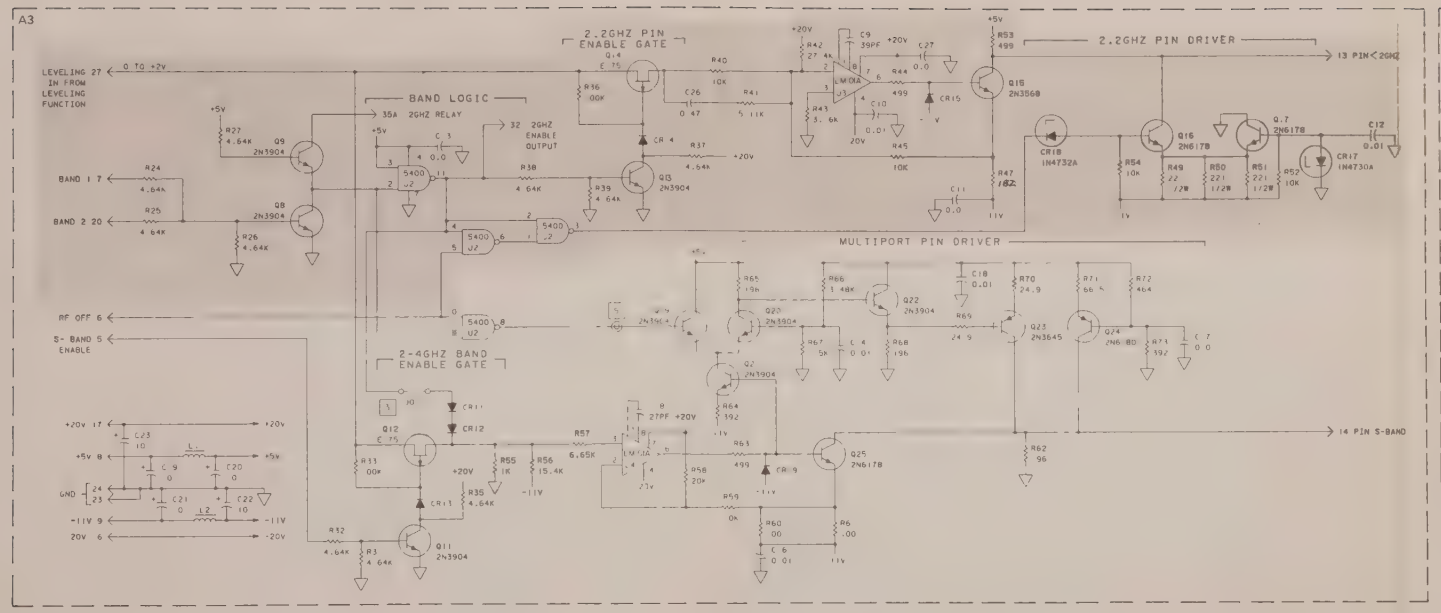
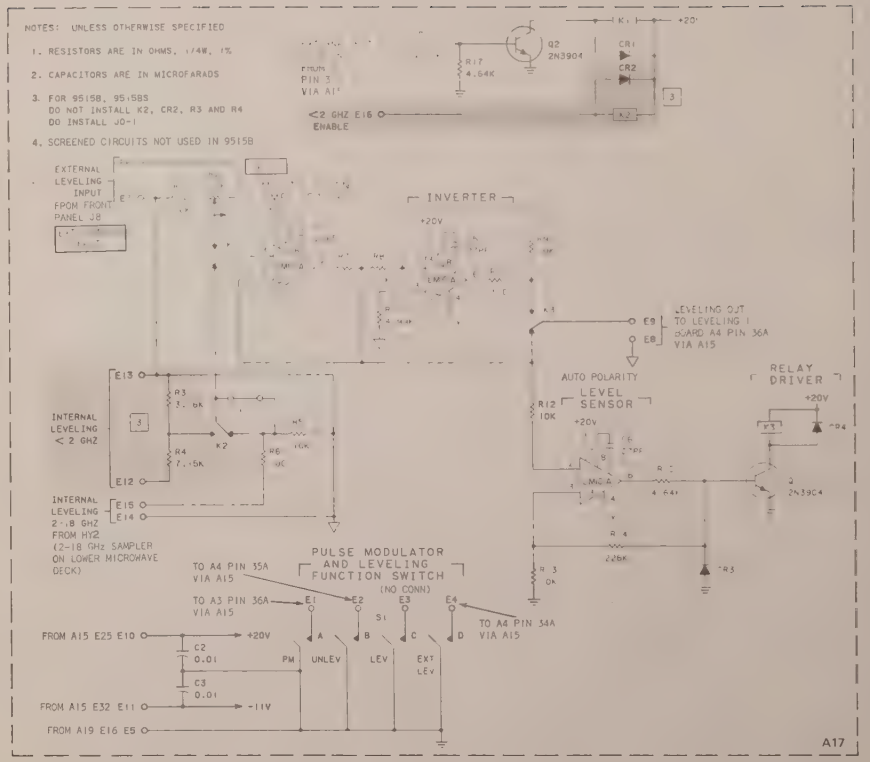


Figure 3-9. P/O PM and Leveling No. 2 Board A3 – Schematic Diagram (106-0878-001)/Assembly Drawing (103-2271-001, Rev 02); Leveling No. 1 Board A4 – Schematic Diagram (106-0901-001)/Assembly Drawing (103-2275-001, Rev 02); Switch Board A17 – Schematic Diagram (106-0902-001/Assembly Drawing (103-2177-001, Rev 05) and Circuit Analysis for All Three Boards (Sheet 1 of 2)




NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE IN OHMS, 1/4W, 1%
2. CAPACITORS ARE IN MICROFARADS
3. FOR 9515B, 9515BS DO NOT INSTALL K2, CR2, R3 AND R4 DO INSTALL J0-1
4. SCREENED CIRCUITS NOT USED IN 9515B
FROM PIN 3 VIA A1
<2 GHZ E16 ENABLE
EXTERNAL LEVELING INPUT FROM FRONT PANEL J8
INVERTER
+20V
LEVELING OUT TO LEVELING I BOARD A4 PIN 36A VIA A15
AUTO POLARITY LEVEL SENSOR
RELAY DRIVER
INTERNAL LEVELING <2 GHZ
INTERNAL LEVELING 2-18 GHZ FROM HY2 (2-18 GHZ SAMPLER ON LOWER MICROWAVE DECK)
PULSE MODULATOR AND LEVELING FUNCTION SWITCH
(NO CONN)
TO A4 PIN 35A VIA A15
TO A3 PIN 36A VIA A15
TO A4 PIN 34A VIA A15
FROM A15 E25 E10
FROM A15 E32 E11
FROM A19 E16 E5
PM
UNLEV
LEV
EXT LEV
-11V
A17

CIRCUIT ANALYSIS – A3 BOARD

A 0 to +2 volt signal from leveling A3 amplifier A4U3 enters the A3 board at pin 27a/b and is applied to the source of S-band PIN gate Q12 and, via resistor R33, to the gate of the same transistor. The S-band enable signal enters at A3-5a/b and is applied to the base of Q11. When the enable signal goes HI (+5V), Q11 saturates and reverses biases CR13; accordingly, the source-drain impedance of Q12 approaches a short-circuit and the 0 to +2 volt control signal is applied to the non-inverting input of PIN driver amplifier U4. The control signal is amplified and applied to the base of Q25. If the LEVEL CONTROL on the controller is turned fully counter-clockwise (no RF output), the input at U4-3 is 0 volts but, due to the voltage offset provided by R58, the output at U4-8 is very near -11 volts. Hence, Q25 is turned off and positive PIN current is provided by Q24 – this current is about 30 milli-amperes and is sufficient to turn-off the S-band port of the PIN switch. When the LEVEL CONTROL is turned fully clockwise, the input at U4-3 rises to approximately +2 volts and turns on Q25. Now the PIN current is the algebraic sum of the negative current from Q25 and the positive current from Q24. The result is a negative current of about 50 milliam-peres; this turns the S-band port full-on (minimun attenuation).

When RF is interrupted (turned off for some finite interval) by either of four control signals (sweep stop, blanking-during-retrace, AM, or PM), and "RF Off" logic signal derived on board A4 enters the A3 board at pin 6a/b. During the RF-Off interval, the level at U2-10 is HI and, since in the 9515, U2-9 is always HI, the output at U2-8 is LO. Hence, the quiescent condition (Q19-On/Q20-Off) of the differential amplifier is reversed, that is, Q19 is turned off and Q20 saturates. Likewise, Q22 is turned off and driver switch Q23 saturates. Under these conditions, Q23 corresponds to a current shunt that "steals" the negative turn-on current from the PIN switch; thus, there is no RF output.

When U2-10 goes LO, the preceding circuit conditions are reversed, that is, Q23 is turned off and the RF output is restored.

CIRCUIT ANALYSIS – A17 BOARD

Switch board A17 performs three functions:

1. Interfaces the various samplers with leveling amplifier A4U3.
2. Provides automatic polarity-selection for the crystal detector used with the sampler.
3. Provides a functional interface between front-panel pushbuttons, the leveling loop, and the PM drivers.

Pushbutton Control. When any one of three pushbuttons (UNLEV, PM-RF OFF, or EXT) on the 9515 is pressed, ground-enable signals, respectively, enter mother board A15 at terminals E153, E154, and E155 and proceed to the appropriate logic circuits on boards A3 and/or A4. If remote leveling board A1 (option) is present, the ground-enable signals enter A15 at terminals E150, E151, and E152 and are connected, respectively, to E153, E154, and E155 via logic circuits in A1. If the remote-select pin on the REMOTE connector of A1 is enabled, internal logic disables the front-panel pushbuttons, that is, the ground-enable signals at terminals E150, E151, and E152 are ignored and remote leveling controls takeover.

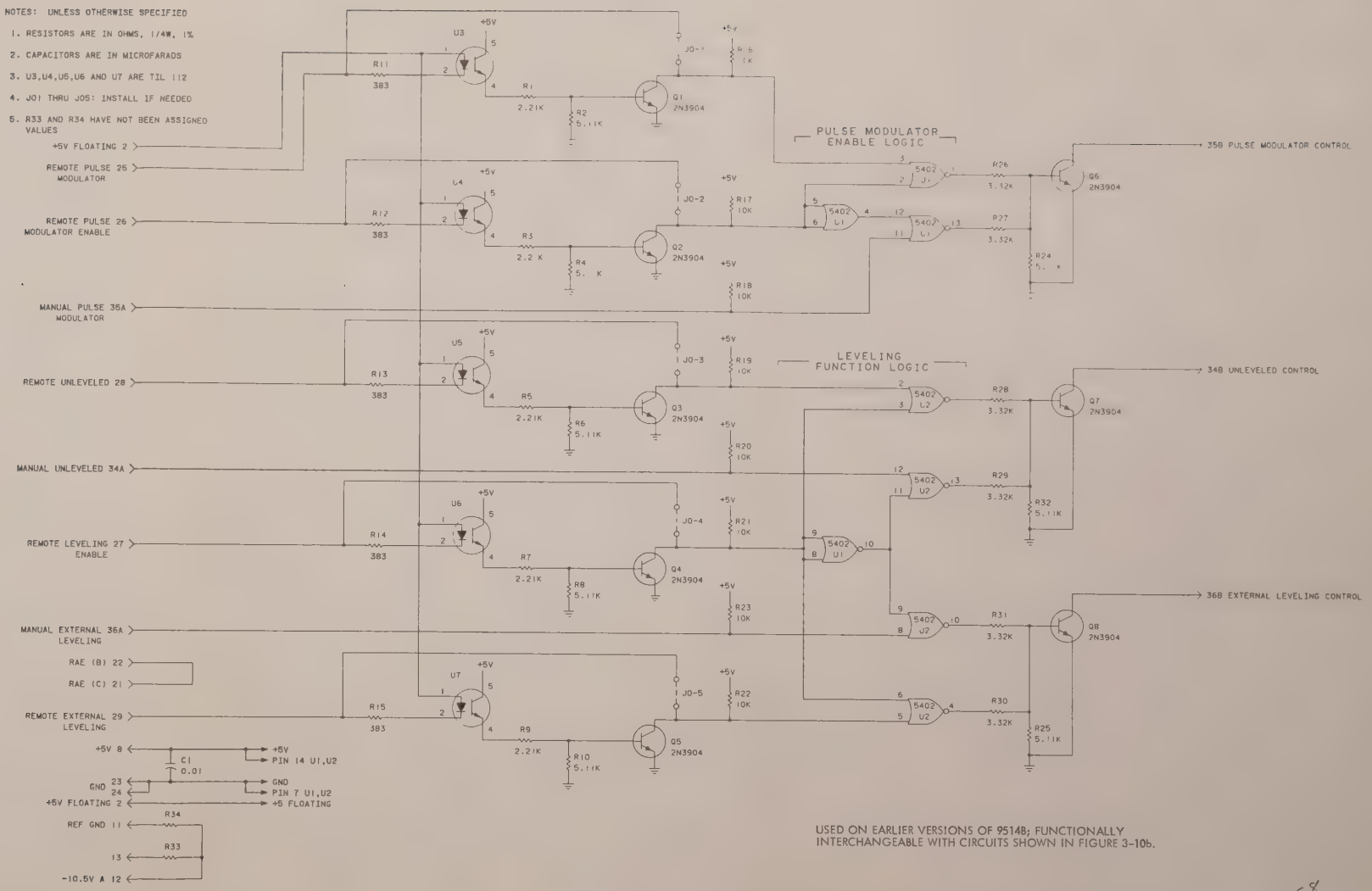
Sampler Inputs/Auto-Polarity Select. When the LEVELING INT pushbutton is pressed, all other pushbuttons on the 9515 are released and the output of the sampler detector enters switch board A17 at terminals E14/E15. The detector voltage (normally negative in polarity) is applied to the non-inverting input of operational amplifier U1 via jumper J0-1 and the deenergized contacts of external sampling relay K1. As described in "CIRCUIT ANALYSIS-External Sampler" for the A4 board, a HI appears at A17/E17 when the LEVELING EXT pushbutton is pressed; thus, relay driver A17Q2 saturates and energizes K1. With K1 energized and an external sampler connected, the detector output is applied to U1-3 via front-panel GAIN control R2. Screwdriver adjustment R2 is set to match the external detector output with the gain characteristics of the leveling loop.

The internal (or external) detector output is amplified by U1 and applied to the non-inverting input of U2. If the detected output of the sampler is negative (normally the case), the output at U1-6 is likewise negative and, since this signal is applied to the inverting input of both U2 and U3, the respective outputs (U2-6 and U3-6) of both amplifiers is positive in polarity. The positive signal at U3-6 saturates Q1 and energizes auto-polarity relay K3. Accordingly, the positive output at U2-6 is applied to the input of leveling amplifier A4U3 via the energized contacts of K3. If the detected output of the sampler is positive, the output at U1-6 is likewise positive; hence, relay K3 is deenergized and the positive input to leveling amplifier A4U3 is as schematically shown.

Figure 3-9. P/O PM and Leveling No. 2 Board A3 – Schematic Diagram (106-0878-001)/Assembly Drawing (103-2271-001, Rev 02); Leveling No. 1 Board A4 – Schematic Diagram (106-0901-001)/Assembly Drawing (103-2275-001, Rev 02); Switch Board A17 – Schematic Diagram (106-0902-001)/Assembly Drawing (103-2177-001, Rev 05) and Circuit Analysis for All Three Boards (Sheet 2 of 2)

CIRCUIT ANALYSIS

Refer to theory associated with Figure 3-10b.



USED ON EARLIER VERSIONS OF 9514B; FUNCTIONALLY INTERCHANGEABLE WITH CIRCUITS SHOWN IN FIGURE 3-10b.

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Figure 3-10a. Remote Leveling Board A1- Schematic Diagram (106-0899-001)

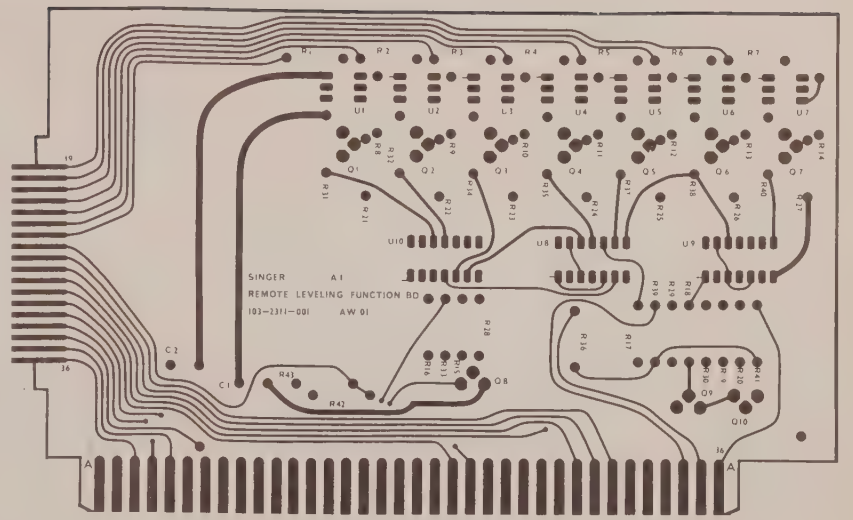
CIRCUIT ANALYSIS

Input to A1 from remote switching is via J2 on the rear panel. This is the socket of A19. Connections are made, pin for pin, from J2 to the plug of A19, which connects to A19, the socket on A1.

The functions on Board A1 are controlled by remote switches, usually by a computer. The remote command for "Unleveled" connects pin 21 of XA19 to the return of the +5V floating supply (pin 1 of A1P1) which is not connected to other circuits in the Emitting Diode of U5 and light shines on the base of the transistor in U5. Current flows from +5V through the transistor and R12 to the base of transistor Q5, which conducts and grounds pin 9 of the NOR gate U8. If pin 8 is also grounded by the Remote Leveling Enable circuit of U6 and Q6, the output of U8 from pin 10 is +5 volts. Current flows through R17 into the base of Q9 and Q9 conducts, grounding pin 34B of P1. This ground signal for unleveled control goes through Mother Board A15, Figure 3-22 to pin 35A of Leveling Board A4, Figure 3-10.

The Remote Leveling Enable circuit operates in the same fashion. Shorting of pin 20 of XA19 to the +5V floating supply return causes current to flow through the LED in U6. Light is emitted and illuminates the base of the transistor in U6. The transistor conducts current which flows through R13 into the base of Q6 which conducts and grounds terminals 11 or 12 of NOR Gate U9, terminal 8 of U8, and terminal 9 of U9. The various functions of the board are thus enabled.

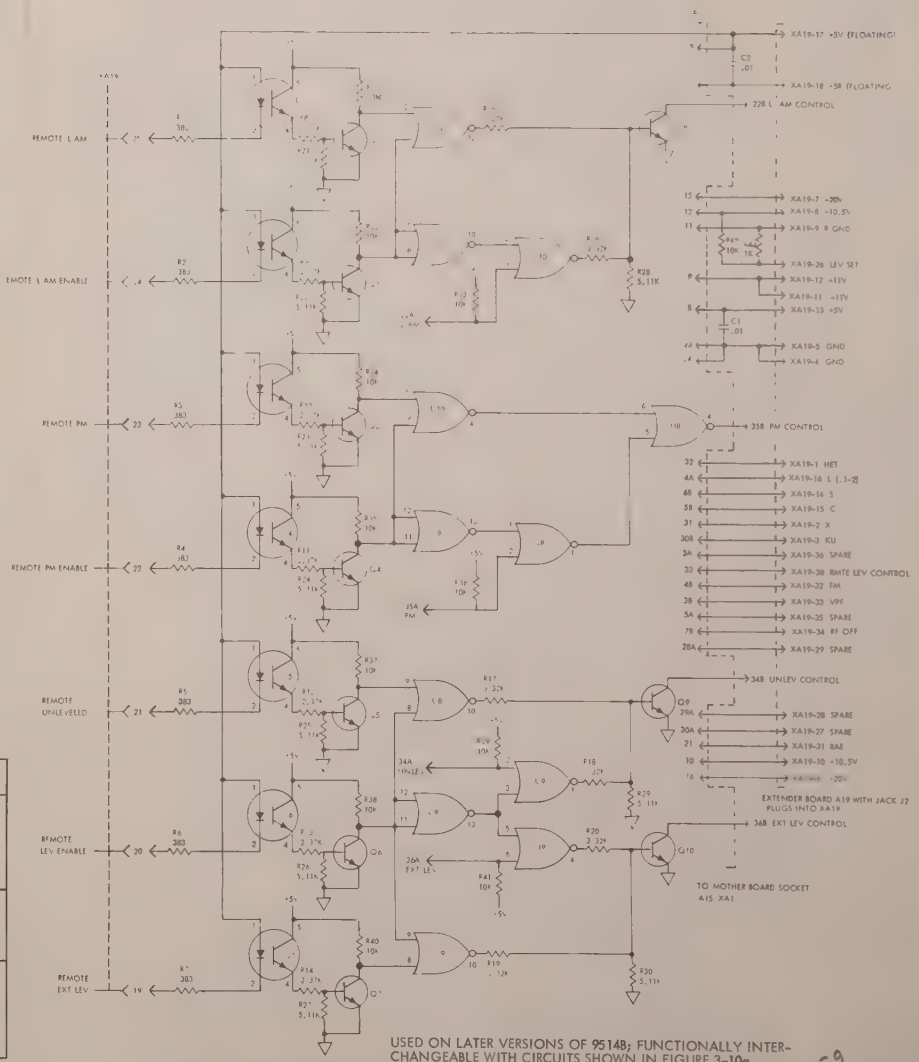
The other logic circuits operate similarly. U10 acts as a gate for AM enable input via pin 22A of A1P1, via pin 3 of U10. U8 acts as a gate for PM enable input via pin 35A of A1P1, via pin 2 of U8. Each gate is enabled by the corresponding remote input.



COMPONENT SIDE

REF DESIGNATORS			
DES	FIRST	LAST	NOT USED
U	1	10	-
Q	1	10	-
R	1	43	-
C	1	2	

NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL TRANSISTORS TYPE 2N2904
2. ALL CAPACITORS IN MICROFARADS
3. ALL RESISTORS IN OHMS, 1/4W, 1%, MF
4. U1-U7: OPTICAL ISOLATOR TIL112
5. U8-U10: TWO INPUT QUAD NOR 54/7402
6. A19 PROVIDES INTERFACE BETWEEN PCB A1 AND REAR PANEL REMOTE FUNCTION CONNECTOR J2. CONNECTION TERMINAL NUMBERS ON XA19 ARE BROUGHT OUT TO J2 ON SAME - NUMBERED PINS



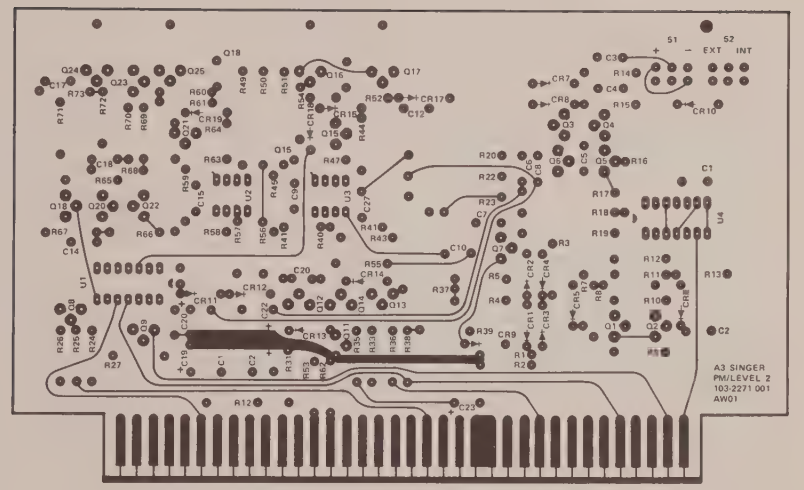
USED ON LATER VERSIONS OF 9514B; FUNCTIONALLY INTERCHANGEABLE WITH CIRCUITS SHOWN IN FIGURE 3-10a.

Figure 3-10b. Remote Leveling Board A1 – Schematic Diagram (106-0920-001), Assembly Drawing (103-2311-001, Rev 01), and Circuit Analysis

TROUBLESHOOTING

Step No.	Symptom	Test Procedure (TP)	Result	Next Procedure
1	Remote functions inoperative.	1. Check +5V floating regulator.	a. No +5V floating.	a. Troubleshoot +5V regulator.
			b. +5V floating OK.	b. Go to Step 2.
2	Linear AM switch on rear panel does not control linear AM input. Remote linear AM is not present.	1. Check voltage at A1 Pin 22A.	a. Voltage is +5V.	a. Replace rear panel S5.
			b. Voltage is 0V.	b. Go to TP2.
		2. Check voltage at A1 pin 22B.	a. Voltage is +5V.	a. Troubleshoot Q8, A1, U10 and U1 and replace faulty components.
			b. Voltage is 0V.	b. Replace A4K3.
3	Remote linear AM function inoperative, okay in internal operation.	1. Check U1, U2, Q1 and Q2.	a. Component open or shorted.	a. Replace faulty component.

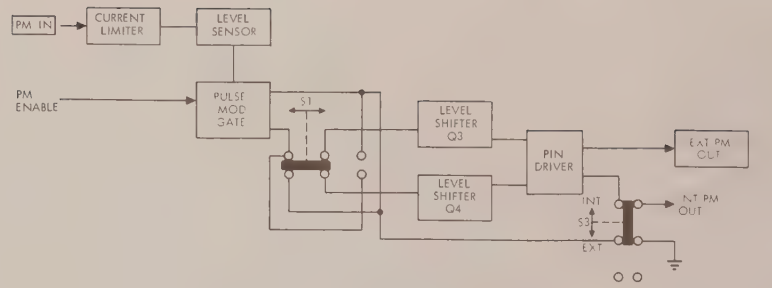
Step No.	Symptom	Test Procedure (TP)	Result	Next Procedure
4	PM inoperative in remote operation, okay in local operation.	1. Check voltage at A1 Pin 35B.	a. Voltage is +5V.	a. Troubleshoot U3, U4, U8, Q3 and Q4 and replace faulty components.
			b. Voltage is 0V.	b. Troubleshoot PM driver.
5	Unleveled mode inoperative in remote, okay in local.	1. Check voltage at A1 Pin 34B.	a. Voltage is +5V.	a. Troubleshoot U5, U6, U7, Q5, Q6, Q7, U8 and U9.
			b. Voltage is 0V.	b. Troubleshoot A4.
6	External leveling inoperative in remote, okay in local.	1. Check voltage at A1 Pin 36B.	a. Voltage is +5V.	a. Go to Step 5, TP1a.
			b. Voltage is 0V.	b. Troubleshoot A4.



COMPONENT SIDE

TROUBLESHOOTING (NOTE: REFER TO LEVELLING LOOP FOR TROUBLESHOOTING OF OTHER COMPONENTS ON BOARD A3)

Step No.	Symptom	Test Procedure (TP)	Result	Next Procedure
1	No INT PM	1. Check that A3, S2 is in int. position.	a. A3, S2 ok. b. A3, S3 incorrect.	a. Go to TP2. b. Replace in int. position.
		2. Check for 0V at A3 Pin 36A.	a. 36A is +5V. b. 36A is 0V.	a. Troubleshoot A1 per Figure 3-6. b. Go to TP3.
		3. Check that there are 0V to +5V pulses at A3, U1 pin 11.	a. Pulses are correct. b. No pulses.	a. Go to TP4 b. Repair diode bridge Q1 or Q2
		4. Check for 0 to +5V pulse at U1 pin 10.	a. Pulses are ok. b.	a. Troubleshoot A4 per Figure 3-3. b. Replace A3, U1.
2	No external PM INT PM ok.	1. Check position of A3,S1, A3,S2 and J01.	a. S2 is in EXT position. S1 is in + position for pin switch with + current for RF off and in the - position with a -current for RF off. J01 is installed only with microwave pin. b. Switch positions are correct.	a. Correct S1, S2 and J01 positions. b. Troubleshoot pin drivers Q3 thru Q7.



PULSE MODULATOR - SIMPLIFIED BLOCK DIAGRAM

BLOCK ANALYSIS

Three functional circuits are contained on pulse modulation and leveling #2 board A3 – the pulse modulating circuits shown and described here, and the L-and-S band leveling amplifiers (part of the leveling loop). The leveling loop is shown and described in Figures 4-8, 4-9, and 4-10.

The pulse modulating circuits provide a current pulse with an exceptionally fast risetime to drive an external PIN modulator. An input pulse enters the instrument at the front-panel PM IN connector. After current-limiting to a value of about 600 millivolts, the pulse is applied to a level sensing circuit, which provides the proper level for application to TTL logic. When the PM button on the front panel is pressed, the PM enable signal permits the pulse to pass through the PM gate and on to the PIN driver, via the level shifters. Refer to schematic notes for operation of the switches and jumper.

CIRCUIT ANALYSIS

The Pulse Modulation circuit is a pulse detector plus logic circuit and amplifier. The input signal into pin 25 of P1 is into a 50 ohm load, R1, R2 and the diode bridge. The diode bridge, CR1, CR2, CR3 and CR4, limits output voltage of the bridge to +1.5 volts for a positive input. This voltage is produced by the current through R4 and CR2, which is approximately 3 mA and the current through R5 which is approximately 2 mA. These combine in R6 to give +1.5 volts. There is no current through CR4, since the input signal drives the positive side of R3 above +1.5 volts, via CR3.

A negative input pulls the negative side of R4 below ground potential via CR1 so that CR2 is cut off. CR3 is also cut off by the negative signal. Current through R5 is approximately 2 mA. Current through R3 and CR4 is approximately 3 mA. Current through CR5 and R7 is approximately 3 mA; hence current through R6 is 4 mA. This makes the voltage into CR5 -1.2 volts.

With no input signal, the junction of CR1 and CR3 is held to ground potential, so the junction of CR2 and CR4 and CR5 is at ground potential. This puts the base of Q1 at -0.5 volts.

The base of Q2 is at +0.3 volts approximately because of currents through R9, R11, R13 and CR6. Q1 is cut OFF for no signal and for a negative signal.

A positive pulse in, or more than 1.5 volts, puts +1.0 volts on the base of Q1; the emitter follows the base and Q2 is cut OFF. R10 raises the voltage on pin 11 of U1 to +5 volts. If PM Enable on pin 36A is at +5 volts, the output of pin 13 of U1 is ground, regardless at voltage on pin 11, and pin 10 of U1 is at +5 volts, allowing full amplitude of the RF output. When PM Enable, pin 36A, is grounded, pin 11 of U1 has control of the gate, and a positive pulse input to Q1 drives pin 11 of U1 to +5 volts, hence pin 13 goes to ground, pin 9 to ground, and pin 10 goes to +5 volts for the duration of the pulse.

Switch S1 chooses the polarity of pulse which is fed to the PIN Diode Attenuator. For the position shown (-) the positive pulse on pin 10 of U1 is fed to the emitter of Q4. The collector of Q4 feeds positive current to the base of Q5, and the collector of Q5 draws the base of Q6 down so that Q6 is cut off. This allows current to flow into the base of Q7, the emitter at which rises to almost +5 volts, to drive external PIN Diodes, which are connected via J7 on the front panel.

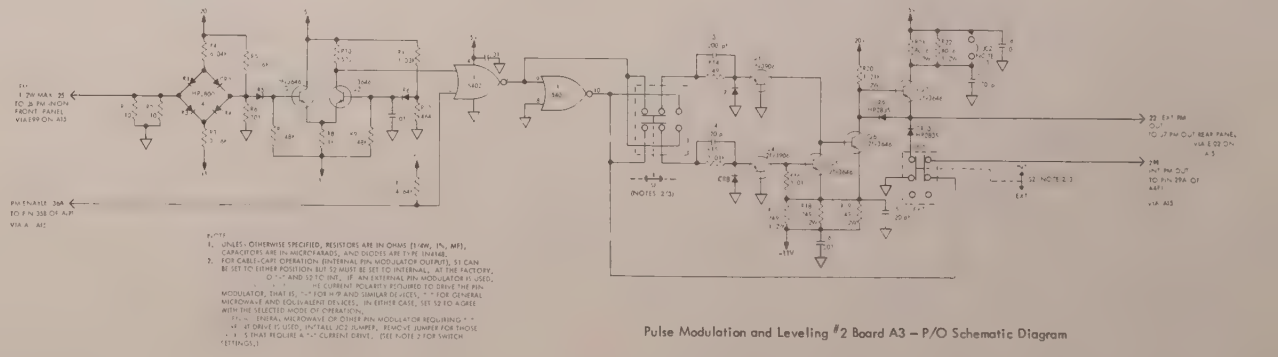
Prior to receipt of the positive pulse at Q4, the negative potential on pin 10 of U1 cut off Q4, while the positive potential on pin 13 of U1 passed current through Q3 into the base of Q6, so that Q6 was saturated and held the voltage on pin 22 down, almost to -11 volts, if S2 was in EXT position.

For S1 in the (+) position, the voltages applied to Q3 and Q4 are reversed, and the pulse output is negative, starting from a positive voltage between pulses.

When S2 is in INT position, the positive pulse from pin 10 of U1 is connected to the modulation circuit on A4. CR10 is connected to ground to prevent the voltage on J7 from going negative, since the load on J7 will require a TTL compatible signal, hence the voltage must go from ground to +5 volts only.

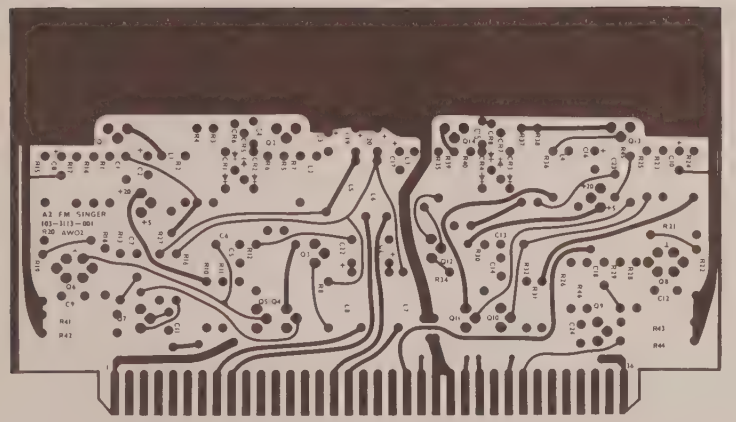
TROUBLESHOOTING

(Refer to levelling loop.)



Pulse Modulation and Leveling #2 Board A3 – P/O Schematic Diagram

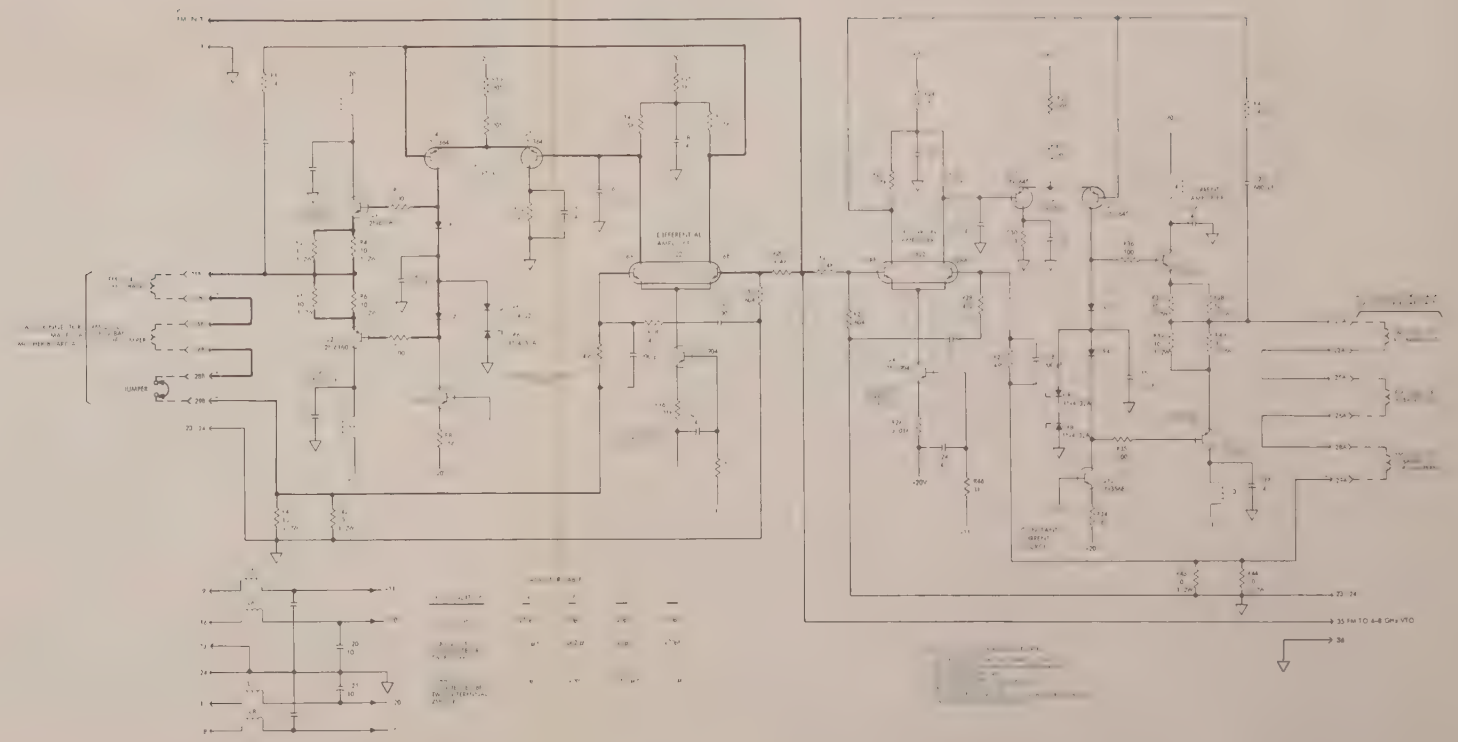
Figure 3-11. Pulse Modulation and Leveling #2 Board A3 – Schematic Diagram (106-0898-001), Assembly Drawing (103-2271-001, Rev 02), and Block/Circuit Analysis

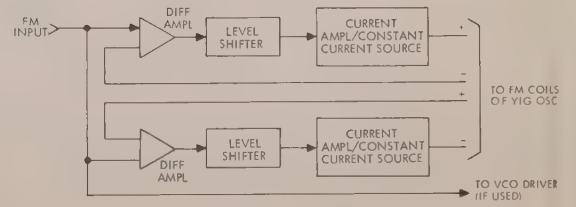


COMPONENT SIDE

TROUBLESHOOTING

Step No.	Symptom	Test Procedure (TP)	Result	Next Procedure
	For units with 4-8 GHz VCO, begin with step 1 For units with 4-8 GHz YIG, begin with step 4			
1	No FM in S band (2-4 GHz) or Het band (.01-2 GHz)	1. Check voltage at A2 pin 21B.	a. Voltage follows input voltage (±1.5V for ±10V input). b. Voltage goes to approximately ±5V for ±10V input. c. Voltage is constant with change in input voltage.	a. Oscillator front coils shorted, replace oscillator. b. FM coil open or circuit between oscillator and mother board. c. Replace Q6 or shorted or open component Q1 thru Q5.
2	No FM in C band (4-8 GHz)	1. Troubleshoot A9 per table 4-1F		
3	No FM in X and Ku band (8-12.4 GHz and 12.4-18 GHz)	1. Check voltage at A3 pin 21A.	a. Voltage follows input voltage (±1.5V for ±10V input). b. Voltage goes to approximately ±5V for ±10V input. c. Voltage is constant with change in input voltage.	a. Oscillator FM coils shorted, replace oscillator. b. FM coil open or open circuit between FM coil on mother board. c. Replace Q8 or open or shorted Q9 thru Q14.
4	No FM in C band (4-8 GHz) X band (8-12.4 GHz) and Ku band (12.4-18 GHz)	1. Go to step 3.		





BLOCK ANALYSIS

The circuits on FM board A2 receive a dc-to-1 kHz FM drive signal from an external source. Two similar channels provide a voltage-to-current conversion to drive the FM tickler coil of the YIG oscillators.

CIRCUIT ANALYSIS

Two amplifiers are used. Transistors Q1 through Q7 form an amplifier which delivers current via pins 21A, 22A, 25A, 26A, 28A, 29A to the Ku Band, X Band, and C Band FM coils. Transistors Q8 through Q14 form a similar amplifier which delivers current via pins 21B, 22B, 25B, 26B, 28B, 29B to the S Band, L Band, and spare FM coils.

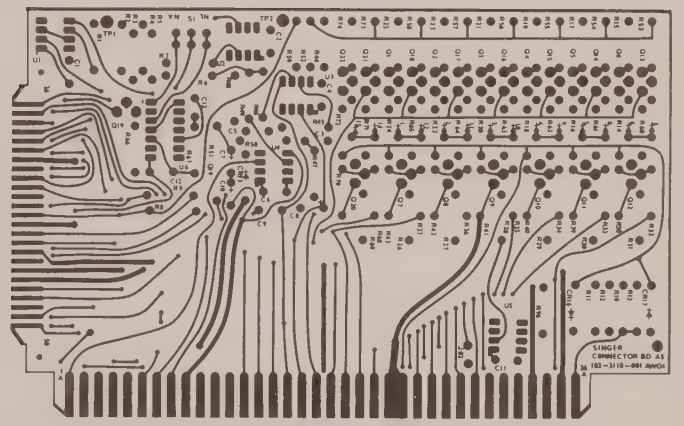
The FM input signal to pin 3 of P1 goes to the base of Q6B. Feedback of voltage across R41 and R42 goes to the base of Q6A. The FM coils current flows through R41, so that current through the coils is held directly proportional to the FM signal voltage.

Outputs from the collectors of Q6 drive the differential level shifters Q4 and Q5. Q3 acts as a constant current source for Q4. Q1 and Q2 are push-pull emitter followers which supply current to the FM coils. Gain of the circuit is sufficient to hold proportionality to ±1 percent.

Signal flow through transistors Q8 through Q14 is exactly like that through Q1 through Q7.

With ±10 volts input, ±300 milliamperes is supplied to the FM tickler coil; with 0-volts input, no drive current is supplied. When a VCO is used, no voltage-to-current conversion is necessary; accordingly, the input voltage is directly, without attenuation, to VCO driver A9.

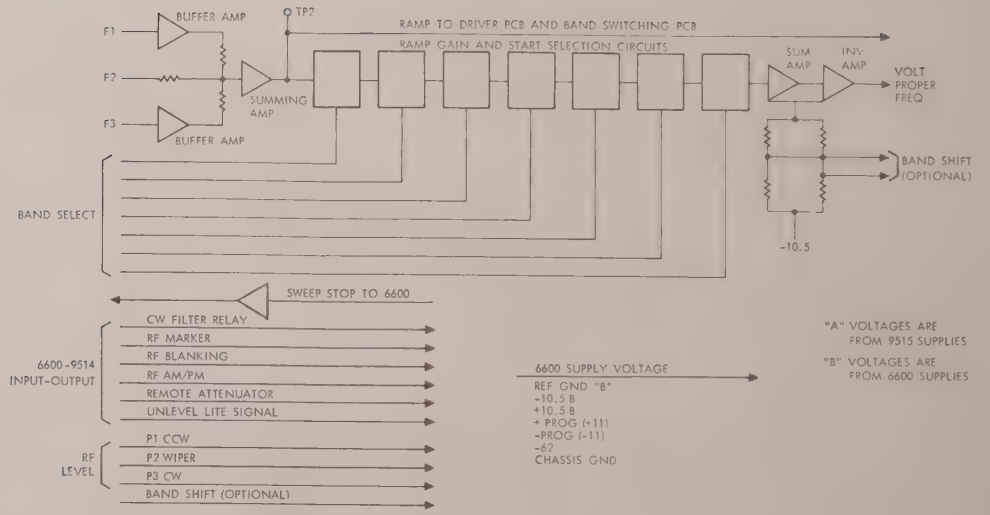
Figure 3-12. Frequency Modulation Board A2 — Schematic Diagram (106-0823-001, Rev 01), Assembly Drawing (103-3113-001, Rev 02), and Block/Circuit Analysis



COMPONENT SIDE

TROUBLESHOOTING--CONNECTOR BOARD A5

Step No.	Symptom	Test Procedure (TP)	Result	Next Procedure
1	No 0-+10V ramp ATA5TP2.	1. Check ramp inputs from 6600.	a. F1, F2, or F3 ramps not present.	a. Troubleshoot 6600.
			b. F1, F2, and F3 ramps OK.	b. Replace U1, U2, or U5. (U1 is F1 ramp consisting of FO fullband and M1 ramp U5 is ΔF and F_o FINE ramp and U2 is M2 and summing for all other ramps.)
2	VPF out of spec in all bands except one.	1. Check start and slope gates and control transistor for the one band that is in spec.	a. Gate or transistor faulty.	a. Replace faulty component.
3	VPF out of spec in all bands.	1. Check U3 and U4.	a. U3 or U4 inoperative.	a. Replace.
			b. U3 or U4 OK.	b. Go to TP2.
		2. Check +62V supply from 6600.	a. No +62V.	a. Troubleshoot 6600.
			b. +62V OK.	b. Go to TP3.
		3. Check CR13 and C7.	a. CR13 or C7 shorted.	a. Replace
			b. CR13 or C7 OK.	b. Go to Step 4.
4	No sweep stop on 6600 ramp sweep stop okay from A6.	1. Check Q19.	a. Q19 OK.	a. Troubleshoot 6600 ramp generator.
			b. Q19 open or shorted.	b. Replace Q19.



CIRCUIT ANALYSIS

Connector board A5 interfaces the 6600 mainframe to the 9514 controller and the 9515 oscillator. The interface connections are made via rear-panel connector J1, plug P1, and mother board A15.

Frequency control inputs F1, F2, and F3 from the 6600 are respectively applied, via the 9514, to input pins A5-9, A5-34, and A5-8. The F1 line supplies F_o, Full-band, and M1 control voltages, F2 supplies the M2 control voltage, and the F3 line supplies ΔF and F_o Fine control. Inputs F1 and F3 are connected to non-inverting unity-gain amplifiers U1 and U5. F2 is summed with the outputs of U1 and U5 by U2, also a non-inverting unity-gain amplifier. The effect of F3 is reduced to ten-percent of its input value, since R4 is ten times larger than the combined resistance of R2 and R3; thus, the output of U2 equals: F1 + F2 + 0.1F3.

The output voltage ramp of U2 is connected to logic board A6, to each of oscillator drivers A8 through A11, and to ramp gain FET gates Q3 through Q6. Start gates Q13 through Q16 are connected to a +10.5 "B" reference voltage. The "ramp gain" and "start" gates are turned on in pairs by the band select signals from the 9514; these signals are initiated by front-panel pushbuttons or by computer board A5 (optional) on the 6600 mainframe.

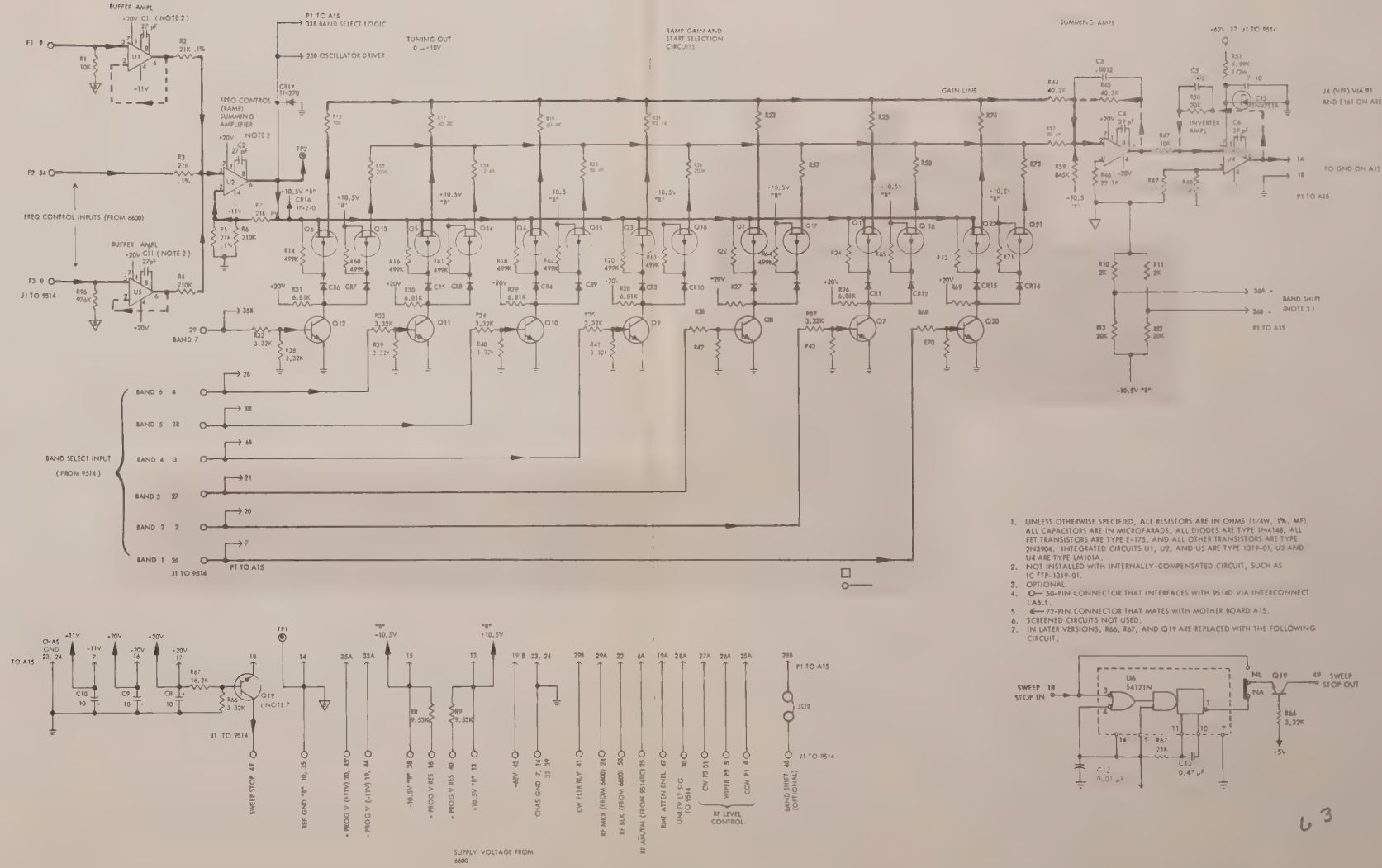
The preceding gates are turned on by saturating either of transistors Q9 through Q12. This removes the positive bias and the associated FET becomes a short circuit for the ramp and reference voltage. Slope resistors R15 through R21 and start resistors R53 through R56 determine the output of U3 which is applied to U4. The output of U4, a times-two amplifier, is applied to the rear-panel VP_f (voltage proportional to frequency) connector on the 9515 oscillator.

Transistor Q19 interfaces the sweep stop of the 9515 with the mainframe ramp-control generator. During oscillator changeover (determined by logic board A6), a LO (approximately 0 volts) is applied to the emitter of Q19 which applies a LO to the ramp generator. This causes the sweep to stop for about 2-milliseconds.

In later versions, the sweep stop signal is applied to Q19 via U6 and S1. (See note 6 on schematic.) With S1 in the NA position, the normal sweep-stop time is extended by about 4-milliseconds – the exact time determined by R67 and C13. In some phase-lock applications, the additional time is required for lockup to occur. For most applications, S1 is set to normal (NL), eliminating U6 from the circuit.

Resistors R8 and R9 program the + and – program supplies of the mainframe for ±11 Vdc. This voltage is applied to relay K1 on power supply module A14. When the 6600 is turned on, A14K1 energizes and supplies line voltage to the power supply rectifiers in the 9515.

Figure 3-13. Connector Board A5 – Schematic Diagram (106-0841-001, Rev 03), Assembly Drawing (103-3118-005, Rev 02), Circuit Analysis, and Troubleshooting (Sheet 1 of 2)



1. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE IN OHMS (1/4W, 1%, MF), ALL CAPACITORS ARE IN MICROFARADS, ALL DIODES ARE TYPE 1N4148, ALL FET TRANSISTORS ARE TYPE E-175, AND ALL OTHER TRANSISTORS ARE TYPE 2N3904. INTEGRATED CIRCUITS U1, U2, AND U5 ARE TYPE 1319-01; U3 AND U4 ARE TYPE LM101A.
2. NOT INSTALLED WITH INTERNALLY-COMPENSATED CIRCUIT, SUCH AS IC #TP-1319-01.
3. OPTIONAL
4. O— 50-PIN CONNECTOR THAT INTERFACES WITH 9514D VIA INTERCONNECT CABLE.
5. ←— 72-PIN CONNECTOR THAT MATES WITH MOTHER BOARD A15.
6. SCREENED CIRCUITS NOT USED.
7. IN LATER VERSIONS, R66, R67, AND Q19 ARE REPLACED WITH THE FOLLOWING CIRCUIT.

Figure 3-13. Connector Board A5 – Schematic Diagram (106-0841-001, Rev 03), Assembly Drawing (103-3118-005, Rev 02), Circuit Analysis, and Troubleshooting (Sheet 2 of 2)

TROUBLESHOOTING – LOGIC BOARD A6

Step No.	Symptom	Test Procedure (TP)	Result	Next Procedure
1	No oscillator or pin select and no sweep stop.	1. Check +5V regulator.	a. No +5V.	a. Troubleshoot oscillator.
			b. +5V OK.	b. Go to TP2.
		2. Check that band enable signals are applied from 9514.	a. No band enable.	a. Troubleshoot 9514.
			b. Band enable OK.	b. Trace signals through to appropriate oscillator select where signal is lost, replace the last component.
2	No S, C or X band pin selects.	1. Check appropriate oscillator select.	a. Oscillator selects OK.	a. Replace U14.
			b. One or more oscillator selects missing.	b. Replace logic IC associated with missing oscillator select.
3	No Ku-band pin select.	1. Check Ku-band oscillator select.	a. Oscillator selects OK.	a. Replace U10.
			b. Oscillator select missing.	b. Replace U11, U12, and U19.
4	One or more oscillator selects missing.	1. Signal trace back to input gates to sweep slope point detectors.	a. Signal missing at some point.	a. Replace last components where signal disappeared.
5	No sweep stop.	1. Check U17.	a. U17 inoperative.	a. Replace
			b. U17 OK.	b. Replace U16 or U20.
6	No band switching.	1. Check input FET gate and drive transistor.	a. FET and drive transistor bad.	a. Replace faulty component.
			b. FET and drive transistor OK.	b. Replace associated sweep slope point detector.
7	No pin drive to 2-pole PIN switch.	1. Check logic at U11-11 and U14-12.	a. Logic OK.	a. Troubleshoot PIN drivers.
			b. Logic incorrect.	b. Troubleshoot L and S band logic.

ADJUSTMENTS – LOGIC BOARD A6

DESCRIPTION:

This procedure describes the adjustments of the switching points between the individual oscillators so that the switching from one oscillator to the next one occurs precisely at the designated dial frequency. The F_o video output marker of the 6600 is used as reference.

The sweep output voltage of the Model 6600 main frame is applied to an oscilloscope. The 6600 is operated in the M1 – M2 sweep mode around a switching point. The F_o marker is then set precisely at the desired switching frequency on the 6600, and the band logic adjusted until the bright spot in the display, caused by the dwell time during the switching interval, coincides with the tip of the F_o marker.

EQUIPMENT:

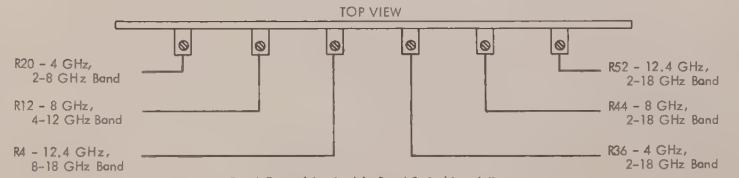
Oscilloscope . . . Tektronix Model 547/Plug-in Model 1A1

PROCEDURE:

Make certain the reference line of the dial on the 6600 lines up with the reference dot on the 6600 dial assembly. This can be set with a screw next to it.

NOTE

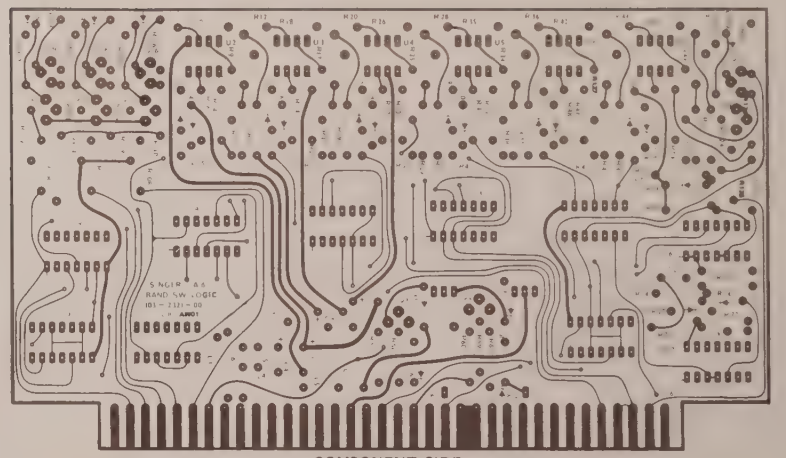
The following adjustments are considered preliminary adjustments. They may have to be altered slightly later for optimum power at the band switching points.


TOP VIEW
R20 – 4 GHz, 2–8 GHz Band
R12 – 8 GHz, 4–12 GHz Band
R4 – 12.4 GHz, 8–18 GHz Band
R52 – 12.4 GHz, 2–18 GHz Band
R44 – 8 GHz, 2–18 GHz Band
R36 – 4 GHz, 2–18 GHz Band

Band Control Logic A6, Band Switching Adjustments

Connect SWEEP output of the 6600 to the EXT HORIZ IN connector of the oscilloscope. Connect MARKER output of 6600 to the channel-1 input of scope. Set 6600/9514 controls as follows:

Sweep time . . . . . 0.01 sec
Sync . . . . . Internal
Sweep . . . . . Full band
Marker amplitude . . . . . Fully clockwise



COMPONENT SIDE

Press 2–8 GHz pushbutton at controller; set M1 to 3.5 GHz, F_o to 4 GHz, and M2 to 4.5 GHz. Adjust R12 to put the intensified portion of the waveform on the tip of the F_o marker.

Press 4–12 GHz pushbutton at controller; set M1 to 7.8 GHz, F_o to 8 GHz, and M2 to 8.4 GHz. Adjust R20 to put the intensified portion of the waveform on the tip of the F_o marker.

Press 8–18 GHz pushbutton at controller; set M1 to 12.2 GHz, F_o to 12.4 GHz, and M2 to 12.6 GHz. Adjust R28 to put the intensified portion of the waveform on the tip of the F_o marker.

Press 2–18 GHz pushbutton at controller; set M1 to 3.5 GHz, F_o to 4 GHz, and M2 to 4.5 GHz. Adjust R36 to put the intensified portion of the waveform on the tip of the F_o marker.

Press 2–18 GHz pushbutton at controller; set M1 to 7.8 GHz, F_o to 8 GHz, and M2 to 8.2 GHz. Adjust R44 to put the intensified portion of the waveform on the tip of the F_o marker.

Press 2–18 GHz pushbutton at controller; set M1 to 12.2 GHz, F_o to 12.4 GHz, and M2 to 12.6 GHz. Adjust R52 to put the intensified portion of the waveform on the tip of the F_o marker.

Applicable to Instruments with Serial No. 151 and Above.

Figure 3-14a. Band Control Logic Board A6 – Schematic Diagram (106-0922-001) and Assembly Drawing (103-2321-001) (Sheet 1 of 2)

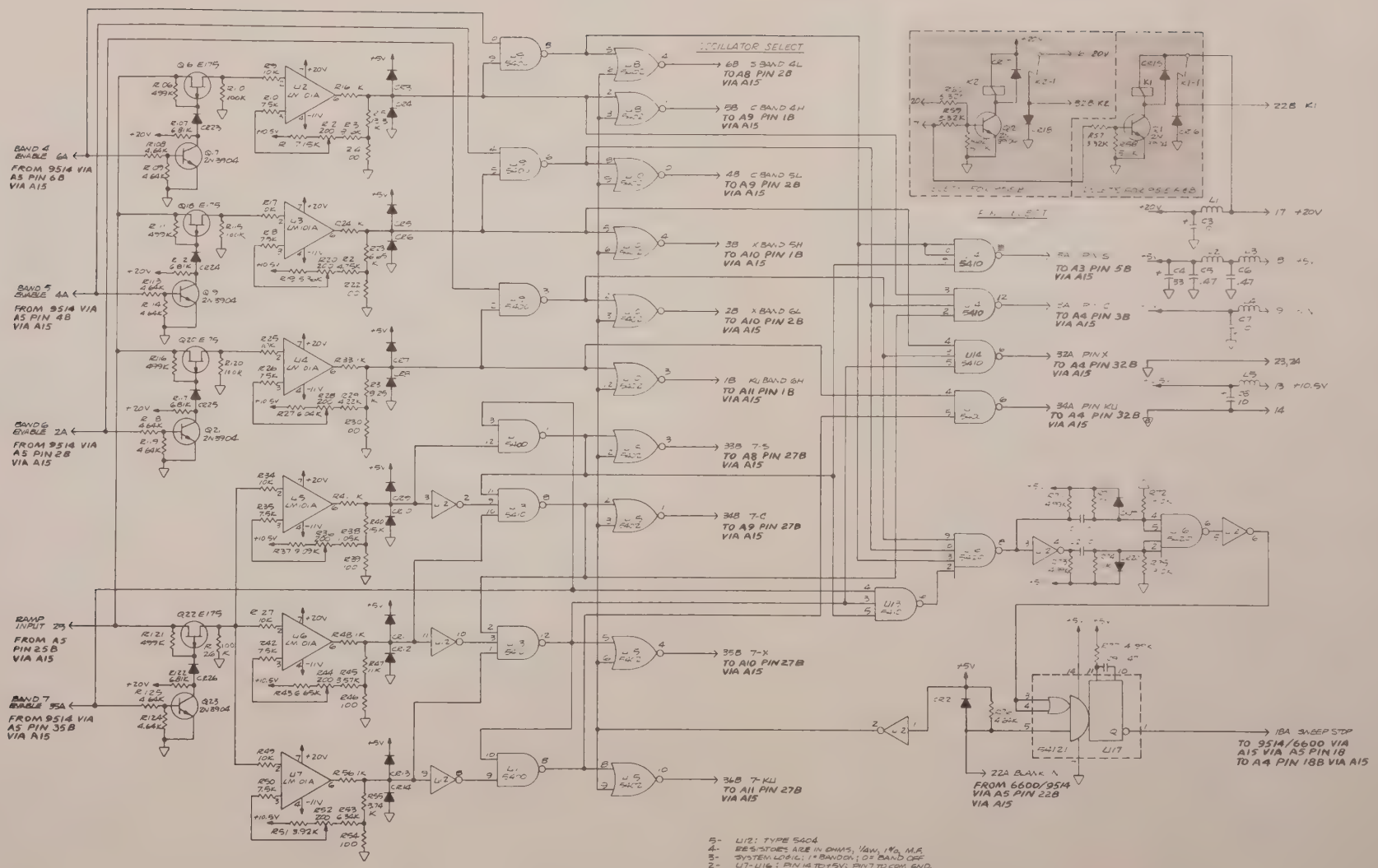
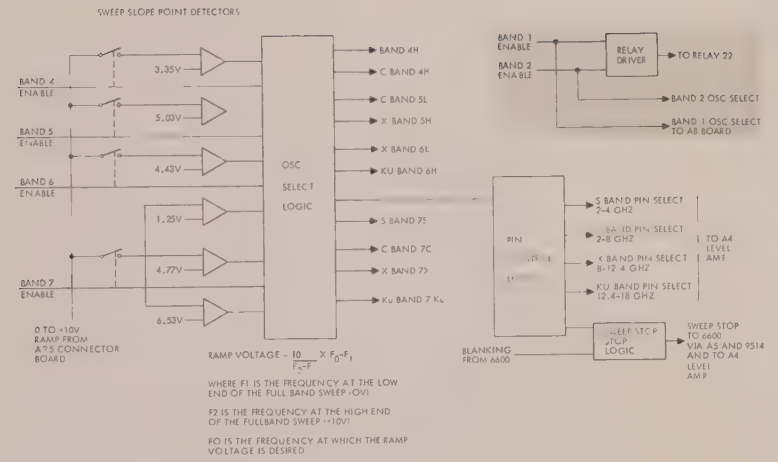
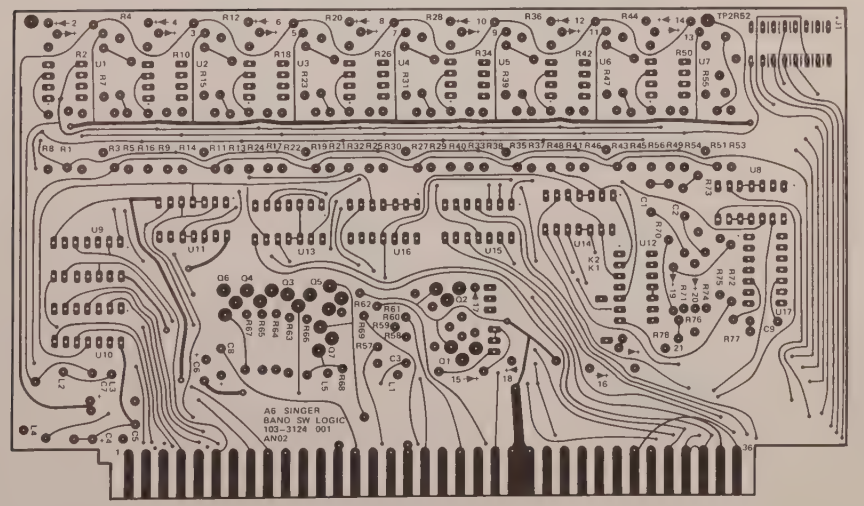


Figure 3-14a. Band Control Logic Board A6 – Schematic Diagram (106-0922-001) and Assembly Drawing (103-2321-001) (Sheet 2 of 2)


SWEEP SLOPE POINT DETECTORS
BAND 4 ENABLE
BAND 5 ENABLE
BAND 6 ENABLE
BAND 7 ENABLE
3.35V
5.03V
4.43V
1.25V
4.77V
6.53V
OSC SELECT LOGIC
BAND 4H
C BAND 4H
C BAND 5L
X BAND 5H
X BAND 6L
KU BAND 6H
S BAND 7S
C BAND 7C
X BAND 7>
Ku BAND 7 Ku
0 TO +10V RAMP FROM A7S CONNECTOR BOARD
BAND 1 ENABLE
BAND 2 ENABLE
RELAY DRIVER
TO RELAY 22
BAND 2 OSC SELECT
BAND 1 OSC SELECT TO A8 BOARD
PIN
S BAND PIN SELECT 2-4 GHZ
SA 10 PIN SELECT 2-8 GHZ
X BAND PIN SELECT 8-12 4 GHZ
KU BAND PIN SELECT 12.4-18 GHZ
TO A4 LEVEL AMP
BLANKING FROM 6600
SWEEP STOP LOGIC
SWEEP STOP TO 6600 VIA A5 AND 9514 AND TO A4 LEVEL AMP
RAMP VOLTAGE = 10/(F2-F1) X (F0-F1)
WHERE F1 IS THE FREQUENCY AT THE LOW END OF THE FULL BAND SWEEP (0V)
F2 IS THE FREQUENCY AT THE HIGH END OF THE FULLBAND SWEEP (+10V)
F0 IS THE FREQUENCY AT WHICH THE RAMP VOLTAGE IS DESIRED



COMPONENT SIDE

TROUBLESHOOTING – LOGIC BOARD A6

Refer to Figure 3-14a.

ADJUSTMENT PROCEDURES – LOGIC BOARD A6

Refer to Figure 3-14a.

CIRCUIT ANALYSIS – LOGIC BOARD A6
(Serial No. 150 and Below)

The Band Control Logic Board provides logic signals to the YIG and VTO driver boards to allow the ramp to tune the oscillators in a sequential order determined by the controls of the 6600 and the 9514, and to select the leveling pins associated with each oscillator on and off. The logic board also provides a sweep stop signal that is sent to the 6600 to stop the ramp for approximately 2 ms while switching from one oscillator to another and to the leveling loop to blank the RF off while this switching is occurring.

The point at which oscillators are switched in relation to the 0–10 volt ramp input is determined by the sweep slope point detectors U2 through U7. U2 will be discussed as all of the detectors operate identically.

Starting with the ramp at 0V, the output of U2, pin 6 will be approximately +15 VDC due to the +3.35 volts on pin 3 supplied by the voltage divider from the +10.5V consisting of R11, R12, R13 and R14 and the 0 VDC ramp on pin 2. When the ramp reached 3.35 volts on pin 2, the output of U2 switches to approximately –10 VDC. This is also fed back, reducing the voltage on pin 3 to approximately 3.3 volts. During retrace when the ramp is going from +10V to 0, U2 will switch at 3.31 volts causing the output of U2 to go again to approximately +15 VDC. This 40 mV hysteresis is necessary to prevent erratic band switching for narrow sweep operation, such as ΔF. The diodes CR3 and CR4 clamp the input to U8 to +5.6 and –0.6 VDC to prevent damage to the logic gate.

The voltage at which the detector switches in the forward direction (0–10V) is determined by the following

$$\frac{10}{F2 - F1} \times BF - F1 + 20\ mV$$

where F1 = the frequency at 0% of the band
F2 = the frequency at 100% of the band
BF = the frequency at which band switching occurs.

(Serial No. 151 and Above):

FET Gates Q16, Q18, Q20 and Q22 control the ramp into the sweep slope point detectors according to the band that is selected by the 9514. For instance if the 2–8 GHz band on the 9514 is selected, +5 VDC will be applied to pin 6A forward biasing Q17 which turns on Q16 allowing the ramp to be applied to U2. At this time all of the other gates are in the off condition so that the other sweep slope point detectors are not allowed to switch.

Since band 7 logic is a little more complex a detailed description follows. The other bands operate the same so they will not be discussed in detail.

Starting with a ramp voltage of 0V and band 7 (2–18 GHz) selected by the 9514, FET gate Q22 is on and the output of U5, U6, and U7 is approximately +15V. This is applied as logic 1 (+5V) to pins 9, 11, and 13 of U12 and pin 12 of U11. A logic 1 is also applied from the 9514 to pin 13 of U11 and pin 4 of U13. Since a logic 1 is applied to pins 12 and 13 of NAND GATE U11, a logic 0 results at pin 11 and is applied to pin 11 of NOR GATE U15 and pin 11 of NAND GATE U13. Pin 12 of U15 is a logic 0 at this time. This results in a logic 1 oscillator select at pin 13 of U15 which is applied to the S Band (2–4 GHz) YIG driver A8. As the ramp reaches 1.255V, U5 switches its output from +15V to –10V which is applied to pin 12 of U11 and pin 13 of U12.

A logic 0, the output of pin 11, U11 goes to logic 1 causing pin 13 of U15 to go to logic 0 removing the oscillator select from A8. At the same time pin 12 of U12 goes to logic 1 and results in a logic 0 at pin 8 of U3. This signal applied to pin 2 of U5, resulting in a logic oscillator select being sent to the C band YIG or VTO driver.

As the ramp reaches 4.77V, the input to pin 11 of U12 and pin 10 of U13 go to logic 0. The logic 0 at pin 10 of U3 results in a logic 1 at pin 8 of U13 and pin 2 of U5, resulting in a logic 0 at pin 1 of U15 which is applied to the C band driver and removes the oscillator select signal. The logic 1 at pin 11 of U2 results in a logic 0 at pin 10 of U12 which is applied to pin 13 of U13 and results in a logic 0 at pin 12 of U13. This logic level is applied to U14–5. This results in a logic 1 oscillator select applied to the X band driver A10.

As the ramp reaches 6.53V, the output of U17 switches state, applying a logic 0 to pin 1 of U13 and pin 9 of U12. The logic 0 at pin 1 of U13 results in a logic 1 at pin 12 of U13 and pin 5 of U15 resulting in a logic 0 applied to the X-band driver.

The logic 0 at pin 9 of U12 results in a logic 1 at pin 8 of U12 and U15 resulting in a logic 1 oscillator select applied to the Ku band YIG driver A11.

When the ramp reaches +10V, the sweep reverses and starts back toward 0V and the logic process reverses except that the switching points are up to 40 mV lower than they were in the forward sweep direction.

If the blanking function on the front panel of the 6600 front panel is enabled, then the oscillators selects are disabled by logic 1 applied to pin 3, 6, 9 and 12 of U15, during the retrace of the sweep for band 7 and pins 3, 6, 9 and 12 of U10 and pins 3 and 6 of U8 for bands 4, 5 and 6.

The pin select logic is determined by the oscillator select logic. Since there are 4 oscillators, 4 pins and 10 oscillator selects, and 4 pin selects, this requires the pins to be selected according to the oscillator selected, independent of the band selected by the 9514.

An example is the selection of band 4 (C-band, 4–8 GHz). At the start of the sweep (2 Ghz), pins 1/2 of U14 are LO and U14–13 is HI. As the sweep ramp reaches 3.35 volts and the 4–8 GHz oscillator is selected, U14–13 goes LO, resulting in a logic 1 pin select.

The sweep stop consists of U16, U17, part of U13, and part of U12.

With band 4 selected and the ramp at 0V, pins 9 and 10 of U16 and pins 3 and 5 of U13 are HI resulting in a logic 1 at pin 8 of U16 when the ramp reaches 3.350V. Pin 13 of 16 goes to logic 1, resulting in a logic 0 at pin 8 of U16. This logic is differentiated by C1 and R71 causing a momentary logic 1 at pin 6 of U16 which is inverted by part of U12 and applied as a trigger pulse to the one shot multi-vibrator U17.

If U8 switches from logic 0 to logic 1, the signal inverted by part of U12 and integrated by C2, R74 and applied through part of U16 and U12 is used as a trigger pulse for U17 (such as during unblanked retrace operation). When U17 is triggered, a positive output pulse, whose width is determined by the RC time constant consisting of R77 and C9 (approximately 2.5 ms) is applied to the 6600 ramp generator to stop the sweep and to the leveling loop as an RF OFF signal when switching for one oscillator to another.

During retrace blanking operation the positve blanking signal applied to U17 pin 5 disables the sweep stop.

Figure 3-14b. Band Control Logic Board A6 – Schematic Diagram (106-0825-001), Assembly Drawing (103-3124-001), Block/Circuit Analysis, and Adjustment/Troubleshooting (Sheet 1 of 2)

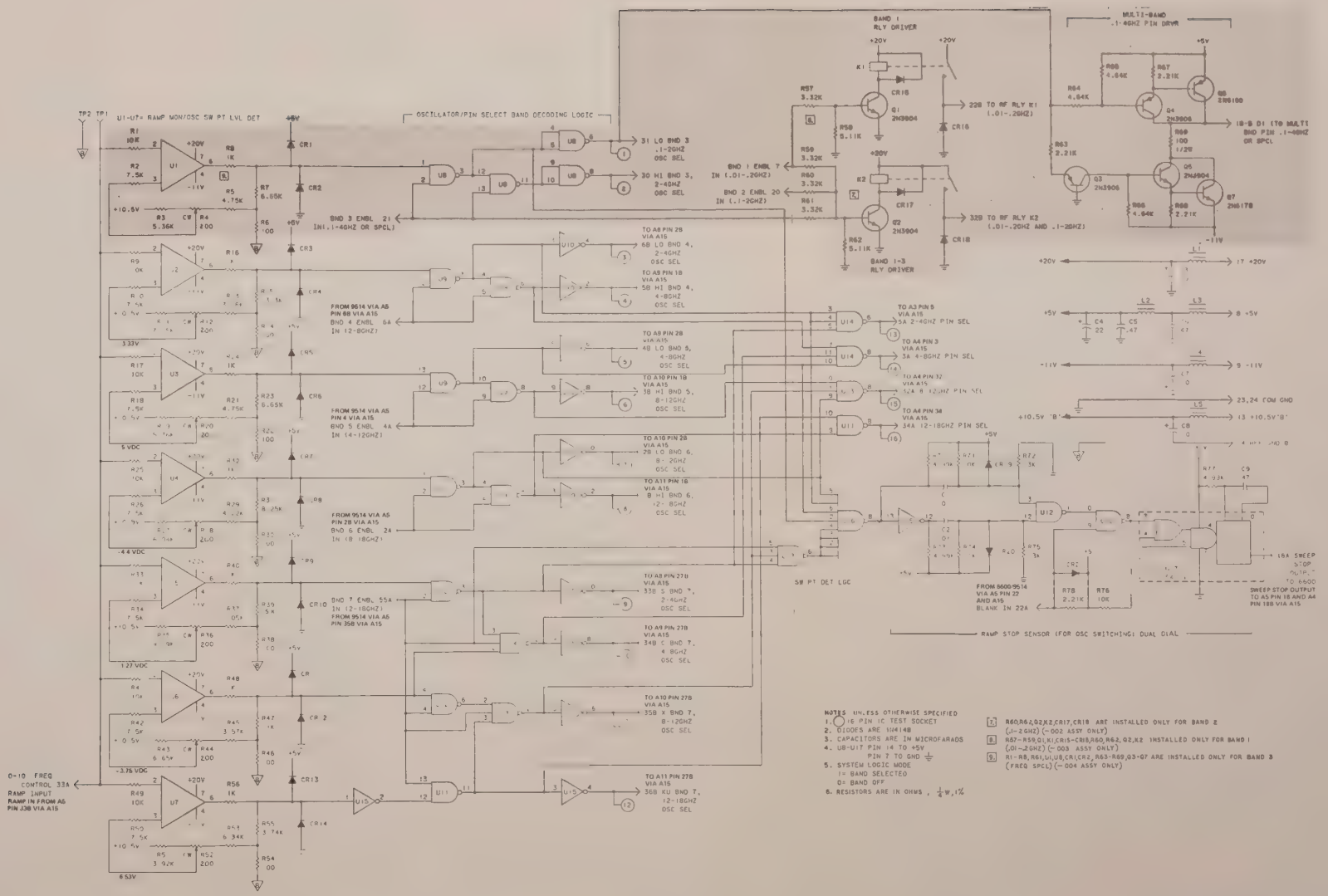

OSCILLATOR/PIN SELECT BAND DECODING LOGIC
U1-U7= RAMP MON/OSC SW PT LVL DET
BAND 1 RLY DRIVER
MULTI-BAND .1-4GHZ PIN DRVR
31 LO BND 3 .1-2GHZ OSC SEL
30 HI BND 3, 2-4GHZ OSC SEL
BND 3 ENBL 21 IN(.1-4GHZ OR SPCL)
BND 1 ENBL 7 IN (.01-.2GHZ)
BND 2 ENBL 20 IN (.1-2GHZ)
22B TO RF RLY K1 (.01-.2GHZ)
32B TO RF RLY K2 (.01-.2GHZ AND .1-2GHZ)
BAND 1-3 RLY DRIVER
TO A8 PIN 2B VIA A15 6B LO BND 4, 2-4GHZ OSC SEL
TO A8 PIN 1B VIA A15 5B HI BND 4, 4-8GHZ OSC SEL
FROM 9514 VIA A5 PIN 6B VIA A15 BND 4 ENBL 6A IN (2-8GHZ)
TO A8 PIN 2B VIA A15 4B LO BND 5, 4-8GHZ OSC SEL
TO A10 PIN 1B VIA A15 3B HI BND 5, 8-12HZ OSC SEL
FROM 9514 VIA A5 PIN 4 VIA A15 BND 5 ENBL 4A IN (4-12GHZ)
TO A10 PIN 2B VIA A15 2B LO BND 6, 8-12GHZ OSC SEL
TO A11 PIN 1B VIA A15 1B HI BND 6, 12-18GHZ OSC SEL
FROM 9514 VIA A5 PIN 2B VIA A15 BND 6 ENBL 2A IN (8-18GHZ)
TO A8 PIN 27B VIA A15 33B S BND 7, 2-4GHZ OSC SEL
TO A9 PIN 27B VIA A15 34B C BND 7, 4-8GHZ OSC SEL
BND 7 ENBL 55A IN (2-18GHZ) FROM 9514 VIA A5 PIN 35B VIA A15
TO A10 PIN 27B VIA A15 35B X BND 7, 8-12GHZ OSC SEL
TO A11 PIN 27B VIA A15 36B KU BND 7, 12-18GHZ OSC SEL
TO A3 PIN 5 VIA A15 5A 2-4GHZ PIN SEL
TO A4 PIN 3 VIA A15 3A 4-8GHZ PIN SEL
TO A4 PIN 32 VIA A15 2A 8-12GHZ PIN SEL
TO A4 PIN 34 VIA A15 1A 12-18GHZ PIN SEL
SW PT DET LOG
FROM 8600-9514 VIA A5 PIN 27 AND A15 BLANK IN 22A
18-B D1 (TO MULTI BND PIN .1-4GHZ OR SPCL)
17 +20V
9 -11V
23,24 FOM GND
13 +10.5V 'B'
8 +5V
16A SWEEP STOP OUTPUT TO 6600
SWEEP STOP OUTPUT TO A5 PIN 1B AND A4 PIN 18B VIA A15
RAMP STOP SENSOR (FOR OSC SWITCHING: DUAL DIAL
0-10 FREQ CONTROL 33A
RAMP INPUT RAMP IN FROM A5 PIN J3B VIA A15
NOTES UNLESS OTHERWISE SPECIFIED
1. 16 PIN IC TEST SOCKET
2. DIODES ARE 1N4148
3. CAPACITORS ARE IN MICROFARADS
4. U8-U17 PIN 14 TO +5V PIN 7 TO GND
5. SYSTEM LOGIC MODE 1= BAND SELECTED 0= BAND OFF
6. RESISTORS ARE IN OHMS, 1/4W, 1%
7. R60,R6 2,Q2,K2,CR17,CR18 ARE INSTALLED ONLY FOR BAND 2 (.1-2GHZ) (-002 ASSY ONLY)
8. R57-R59,Q1,K1,CR15-CR18,R60,R62,Q2,K2 INSTALLED ONLY FOR BAND 1 (.01-.2GHZ) (-003 ASSY ONLY)
9. R1-R8,R61,U1,U8,CR1,CR2,R63-R69,Q3-Q7 ARE INSTALLED ONLY FOR BAND 3 (FREQ SPCL) (-004 ASSY ONLY)

Figure 3-14b. Band Control Logic Board A6 – Schematic Diagram (106-0825-001), Assembly Drawing (103-3124-001), Block/Circuit Analysis, and Adjustment/Troubleshooting (Sheet 2 of 2)

TROUBLESHOOTING – COMMON TO ALL YIG DRIVERS

Step No.	Symptom	Test Procedure (TP)	Result	Next Procedure
1	No RF output in the 4–8 GHz section of any band.	1. Check +15V bias at +15V terminal of VCO.	a. No +15V.	a. Go to Step 2.
			b. +15V OK.	b. Go to TP2.
		2. Check pin current for 4–8 GHz part of 4 pole pin per Figure 3–3.	a. Pin current is not correct.	a. Troubleshoot A4 per Figure 3–3.
		3. Check tuning voltage at A9 TP3 is +3V at 4 GHz and –40 at 8 GHz.	a. Tuning voltage is –60 and does not change with input ramp.	a. Troubleshoot CR8, Q14 and Q15, replace faulty components.
			b. Tuning voltage is +10V and does not change with ramp input.	b. Troubleshoot Q13 and CR10 and replace faulty components.
			c. No–62V applied to A9.	c. Troubleshoot 6600 –62V supply.
			d. Tuning voltage OK.	d. Go to TP4.
		4. Check +15V current with clip–on milliammeter. Should be +200 to +250 ma.	a. Too high or too low.	a. Replace VCO and driver.
			b. Current OK.	b. Go to TP5.
		5. Check RF directly out of VCO with 20 dB attenuator and power meter or detector.	a. No RF power.	a. Replace VCO and driver.
			b. RF power OK.	b. Troubleshoot RF signal flow to front panel output.
2	No +15V bias.	1. Check for shorted C3 across bias terminal and ground at VCO.	a. C3 shorted.	a. Replace.
			b. C3 OK.	b. Go to next step.
		2. Check A9CR23.	a. CR23 shorted.	a. If CR23 is shorted, this indicates an over voltage condition has occured. Troubleshoot Q23, Q27, Q29 and U4 by removing +15V lead from VCO and attaching a 60 load resistor from the +15V lead to ground.
			b. CR23 OK.	b. Go to TP3.
		3. Check A9C12.	a. C12 shorted.	a. Replace.
			b. C12 OK.	b. Go to TP4.
		4. Check A9, Q27, Q23, Q29 and U4.	a. One or more components bad.	a. Replace faulty components.
3	Frequency excessively high or low in 4–8 GHz section of all bands.	1. Check A9, Q4 and A9 Q8.	a. Shorted or open component.	a. Replace.
			b. Q4 and Q8 OK.	b. Go to TP2.
		2. Check FM amp A9U3.	a. FM amp output + or – 15V with no input.	a. Replace U3.
			b. FM amp OK.	b. Go to TP3.
		3. Check linearization network A9Q16 through A9Q25.	a. Faulty components in network.	a. Replace.
4	Frequency OK in 4–8 section of one band, but high or low in all others.	1. Check FET gates and control transistor for the 4–8 band in which the frequency is OK.	a. Open or shorted component.	a. Replace faulty component.
5	Frequency is nonlinear.	1. Check cardinal points on 4–8 section of 4–12 band.	a. Frequency nonlinear.	a. Adjust per calibration procedure.
			b. Frequency linear.	b. Go to TP2.
		2. Check linearity in other bands.	a. Frequency non–linear in other band.	a. Adjust high and low end frequency adjust for band that is nonlinear per calibration and adjustment procedures.
6	Excessive residual FM only in 4–8 section of all bands.	1. Check A9K1 and A9Q26 and A9C11.	a. Open or shorted.	a. Replace.

ADJUSTMENTS – COMMON TO ALL YIG DRIVERS

FREQUENCY TEMPERATURE COMPENSATION ADJUSTMENT OF YIG TUNED OSCILLATORS

This adjustment has to be performed only after either component had to be replaced in the temperature compensation circuit or a YIG tuned oscillator had to be replaced.

REFERENCES:

Figures 3–17, 3–18, 3–19, and 3–20.

DESCRIPTION:

The frequency temperature compensation adjustment applies only to YIG tuned oscillators, not to the varactor tuned 4–8 GHz oscillator. Since the adjustment procedure is identical for all YIG tuned oscillators, it will be described only for the A9 (YIG) board. However, the same 2 controls appear on the A8, A10 and A11 boards.

The adjustment corrects for the frequency temperature coefficient of the YIG tuned oscillators by changing the tuning current automatically as a function of ambient temperature, to keep the RF frequency constant. For the 2–4.2 GHz oscillator, this adjustment is performed at 2.3 GHz (at 100 MHz for the heterodyne unit, since 2.3 GHz is converted to 100 MHz), while for the 4–8 GHz, 8–12.4 GHz and the 12.4–18 GHz oscillators it is done around the center frequencies.

This adjustment is performed by measuring the frequency in the F_0 mode just after turn–on of the instrument, letting it warm up, and then setting the frequency after the warm up back to the value which was measured just after the turn on.

EQUIPMENT:

RF/Microwave Frequency Counter . . . . . EIP 351D
Digital Voltmeter . . . . . Fluke 8300A

PROCEDURE:

The temperature compensation procedure has to be performed for one oscillator at a time.

The above figure shows the locations of the temperature compensation adjustment on the A9 (YIG) board. The locations of these adjustments on the A8, A10 and A11 boards are identical to the A9 (YIG) board.

Push "F_0" button. For the 2–4.2 GHz YIG tuned oscillator frequency temperature coefficient compensation, set F_0 to 100 MHz in the 0.1–2 GHz; for the 4–8 GHz YIG tuned oscillator, set F_0 to 6 GHz in the 4–8 GHz band; for the 8–12.4 GHz YIG tuned oscillator, set F_0 to 10 GHz in the 8–12.4 GHz band; and for the 12.4–18 GHz YIG tuned oscillator, set F_0 to 16 GHz in the 8–12.4 GHz band.

Turn unit on, and allow to warm up for 15 minutes. Connect DVM between TP3 and TP2 (GND). Adjust temperature compensation balance potentiometers R48 to 0V ±3 mV. Record frequency.

Allow the unit to warm up 15 more minutes. Without touching any frequency control, adjust the temperature compensation adjust potentiometer R49 to bring the frequency back to the value recorded after the first 15 minutes.

After the temperature coefficient compensation adjustment, allow the unit to warm up for a full hour. Then check the frequency accuracy. If adjustments are necessary, see Adjustment Procedure.

CIRCUIT ANALYSIS – COMMON TO ALL YIG DRIVERS

With no oscillator–select signal from A6, transistors Q4, Q5, Q6, and Q7 are turned off and, with the exception of Q8 (idle signal), all the FET gates are turned off. With Q4 turned off, CR4 is reverse–biased and Q8 is turned on; accordingly, +10.5 volts appears across R29/R62 and sets the tuning current to approximately 1 percent below the lowest frequency in the range.

Assume band 7S is enabled. The band–idle gate opens (Q8 turns off) and Q7 conducts, causing Q1, Q11, and Q12 to conduct. Thus, three voltages are summed at the inverting input of operational amplifier U3 – the 0 to +10V tuning ramp via R9/R10/R64, the ±10.5V reference via R37/R38/R62, and the tuning current feedback via R80/R68; a reference ground signal is applied to the noninverting input of U3 via R40/R61. The output of U3 drives tuning–current amplifier Q16/Q17/Q18/Q19 which, in turn, supplies the YIG tuning current via R80.

At fast sweep speeds, where greater voltage is required to drive current through the inductive tuning coil, diode CR12 is reverse biased and the tuning current is furnished from the –20V supply via Q18. This provides low power dissipation and, at the same time, provides the higher voltage required for fast sweep speeds. Diodes CR13 and CR14 clamp the back EMF of the tuning coil to + and –20 volts. Capacitor C30 and resistor R101 effectively reduce the value of R80 at fast sweep speeds increasing the current through the magnet coil to reduce frequency shift of the oscillator with sweep speed. When the CW mode of operation is selected, pin 25 is grounded turning of Q15 which energizes K1. This connects C9 and C11 through C16 in the circuit to reduce residual FM.

A silicon diode mounted on the oscillator heatsink is forward biased by +10.5 V_b via R45. This voltage will change with temperature and is summed with a fixed voltage from the –10.5V supply. A zero adjustment is provided to compensate for diode differences. J0–2 and J0–3 are provided so that the oscillator may be compensated in a "–" or "+" direction. The wiper voltage of R48 is amplified by U2 and applied to R49 which is adjusted for the proper temperature–compensating voltage.

The bias voltage circuits provide the bias voltage for operation of the oscillator. The output is fed back to series–pass transistor Q23 via summing amplifier U4 and corrects for line–and–load changes. The output voltage is also compared with +5V by Q25 through a resistive divider comprising CR17/R89/R90/R92. If the voltage exceeds the limit set by R90, Q25 conducts and controls the bias of the series–pass transistor via Q22 – keeping the output at the preset level. If the output is short–circuited or overloaded, the excessive current is sensed by R8 and Q22 reduces the output current to a safe limit. Resistor R87 provides a soft foldback so that under short–circuit conditions, the current is further reduced to keep the power dissipation of Q23 within safe limits.

Diode CR15 provides further overvoltage protection in case of a failure of the overvoltage circuit. F use F3 opens in the event the current–limit circuits fail.

Some oscillators require that the bias voltage can be changed with frequency or that a variable bias be used to provide greater power, better harmonic response, and less spurious emissions. This is accomplished by resistor R99 and jumper J0–1. For lower (less positive) biases, J0–1 is installed for negative output; for higher (less negative) biases, J0–1 is installed for a positive output. The voltage across R80 (tuning current sense) is summed through R99 into U4 so that the bias voltage is changed to produce the best linearity and frequency response.

ADJUSTMENTS – YIG DRIVER A8

The tolerances in adjusting the frequencies are such that at the frequency switch points of multiband frequency ranges there is always a frequency overlap, never a frequency gap.

Some 9515 oscillator units use a Varactor tuned 4–8 GHz oscillator. Due to the non–linearity of the tuning voltage versus frequency relationship of a varactor tuned oscillator, a linear circuit is used which requires several frequency adjustments within the 4–8 GHz band.

The adjustment procedure for both, the 4–8 GHz YIG tuned oscillator and the 4–8 GHz Varactor tuned oscillator is described below.

EQUIPMENT:

Frequency Counter . . . . . EIP 351D
Digital Voltmeter . . . . . Fluke 8300A

PROCEDURE:

Turn unit under test on and allow to warm up for at least one hour. Push "F_0" button, and connect counter to the RF output.

Push frequency band button on 9514 as shown. Set F_0 pointer to dial frequency shown, always approaching it from the low end. Using the adjustment called out in set, set counter indicated frequency to value shown in Table within the given tolerances.

FREQUENCY ADJUSTMENTS FOR 2–4 GHz OSCILLATOR

Band (GHz)	Schematic Reference	Dial Frequency	Actual Output Frequency	Adjustment (Reference Designation)
2–8	4–14	2.0 GHz	2.0 GHz (±10 MHz)	A8P31
2–8	4–14	3.9 GHz	3.910 GHz (±5 MHz)	A8P15
	4–14		100 MHz (–0, +10 MHz)	A8R4
	4–14		1.805 GHz (±5 MHz)	A8R2
2–18	4–14	2.0 GHz	2.00 GHz (±5 MHz)	A8R37
2–18	4–14	3.9 GHz	3.910 GHz (±5 MHz)	A8P9

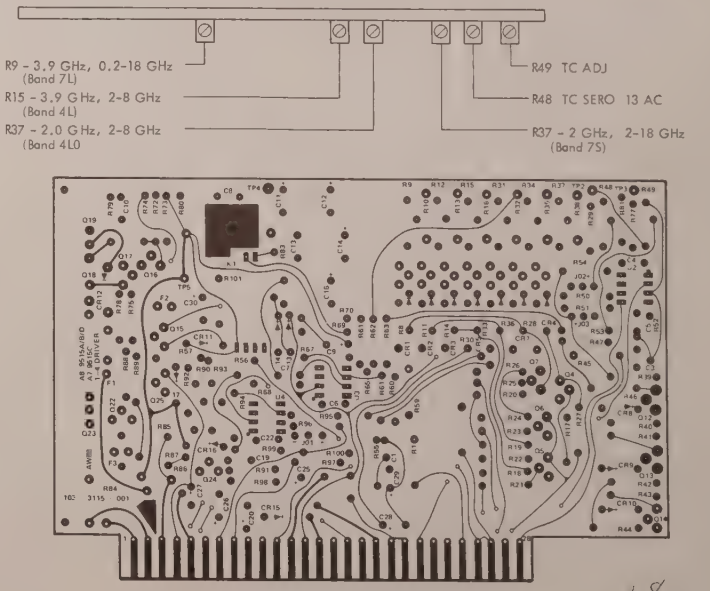
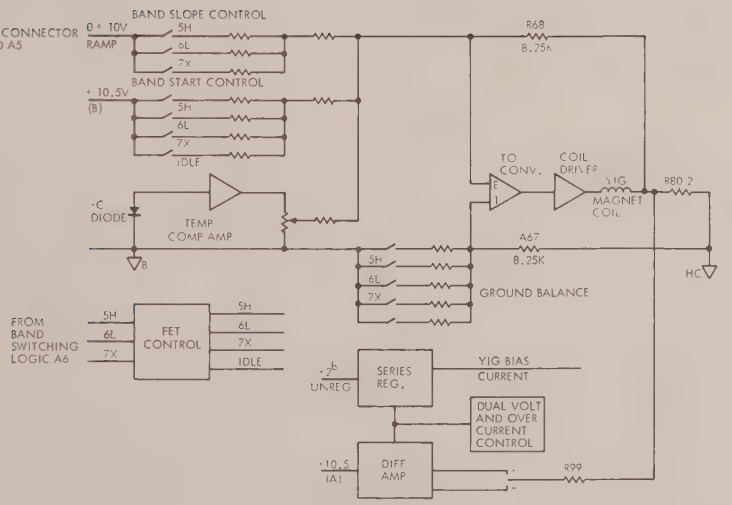


Figure 3–15. YIG Driver Board A8 – Schematic Diagram (106–0816–001), Assembly Drawing (103–3115–001), Block/Circuit Analysis, and Adjustment/Troubleshooting Data (Sheet 1 of 2)



BLOCK ANALYSIS – YIG DRIVER
(Common to All YIG Drivers)

The 9515 YIG driver consists of three primary circuits – a YIG magnet (tuning current) driver, the band-control circuits, and the YIG bias supply.

Tuning currents through the magnet coil and resistor R80 are supplied by a current driver. The voltage across R80 is fed back to the current converter (summing amplifier), providing a constant current source for the YIG magnet coil. A 0 to +10V ramp, a "start" voltage from the ±10.5 V_b reference supply, and a temperature-compensation voltage is also applied to the summing junction.

FET gates (shown in block diagram as relays) are controlled by FET control circuits in conjunction with logic commands from board A6. When an oscillator select signal is received from A6, a band-slope FET gate, a band-start FET gate, and a ground-balance gate close – the "idle" FET gate is opened.

YIG DRIVER – BLOCK DIAGRAM
(Common to All YIG Drivers)

The ramp, temperature-compensation, and reference voltages are summed with the feedback from R80 through R86. Accordingly, the YIG magnet current is changed and the oscillator frequency is likewise changed. The temperature compensation voltage is dependent upon the forward junction voltage of a silicon diode mounted on the YIG heatsink; thus, frequency drift with temperature of the YIG is improved. The "idle" gate provides an input to the summing amplifier when oscillator is not selected. This idle input sets the frequency to approximately 1 percent below the lowest value – about 7.92 GHz for X-band. Moreover, the idle signal keeps the oscillator "on" and ready to sweep when called-up by the oscillator-select logic from A6; with the oscillator "on", better temperature stability is obtained.

The ground-balance circuits form a bridge between the 6600 reference ground and the high-current ground of the 9515. Hence, ground-loop currents are eliminated and the result is very low residual FM. In the CW mode of operation, K1 is energized via the mainframe and capacitors C11 through C18 are connected across the YIG magnet to further reduce residual FM.

Capacitor C30 and resistor R101 provides phase-lag compensation to reduce frequency-shifting of the YIG with changing sweep speeds – particularly those faster than 100 milliseconds.

The bias supply provides proper voltages and currents to the YIG oscillator. The supply is over-voltage protected and current limited. In case of overvoltage failure, CR15 shorts and folds back the supply to 0V; if all protective circuits fail, fuse F3 opens and removes bias voltages from the oscillator.

Resistor R99 and jumper R0-1 are provided for supply tuning. Some oscillators require this option; with others, it is not required. Supply tuning consists of changing the bias supply voltage to the oscillator during frequency tuning. Resistor R99 sums the voltage across R80, which is proportional to YIG magnet current (oscillator frequency), with the reference voltage applied to the operational amplifier. Jumper J0-1 provides the option of moving the bias voltage more positive with an increase in tuning current or more negative with a decrease in tuning current.

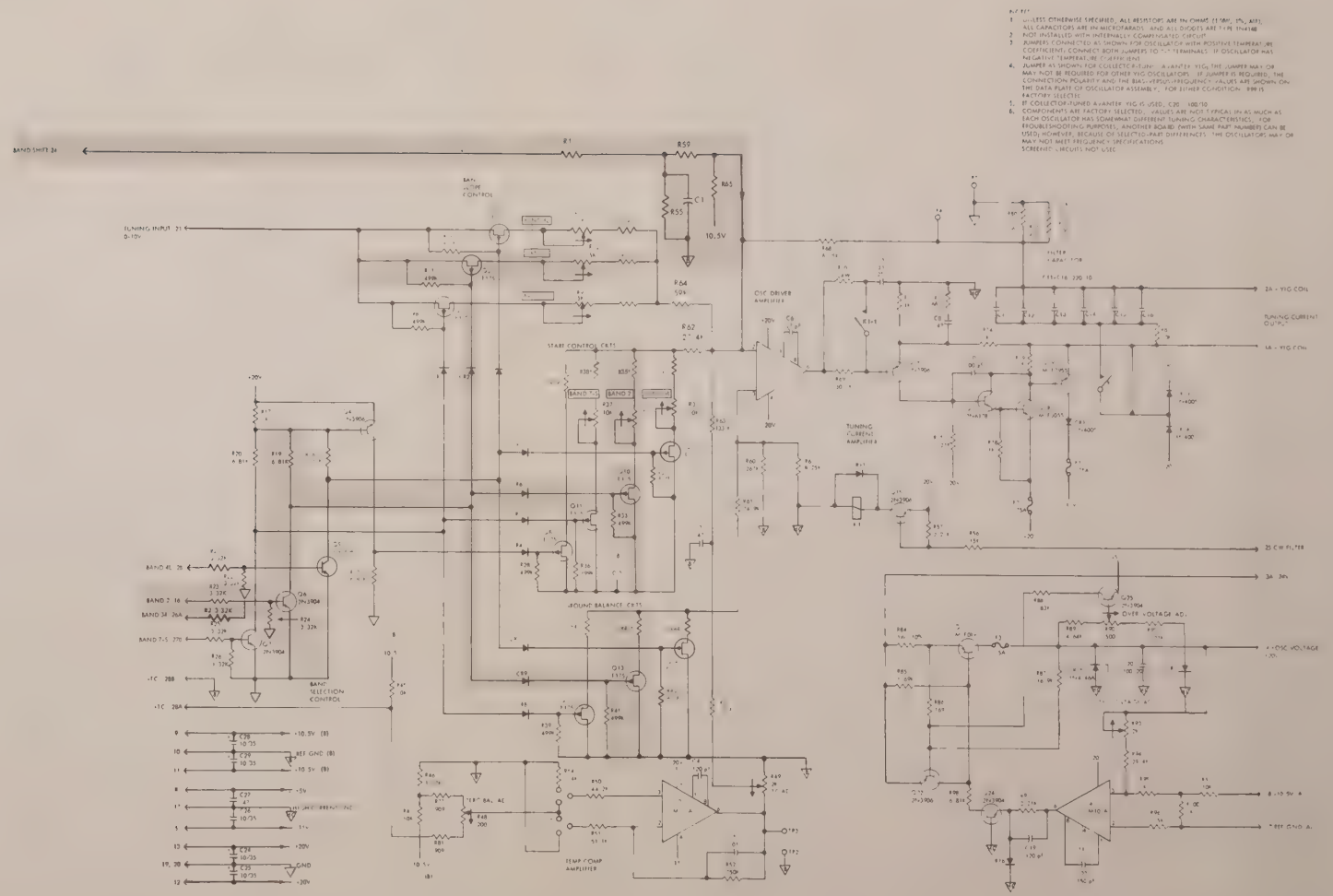


Figure 3-15. YIG Driver Board A8 – Schematic Diagram (106-0816-001), Assembly Drawing (103-3115-001), Block/Circuit Analysis, and Adjustment/ Troubleshooting Data (Sheet 2 of 2)

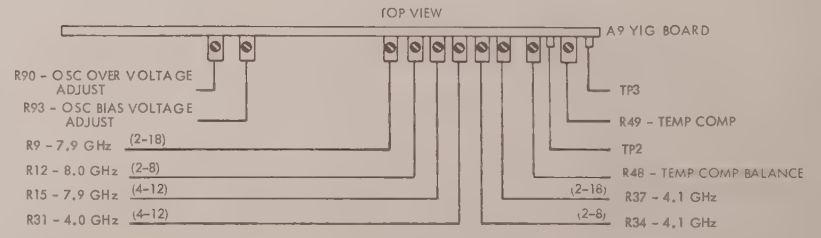
TROUBLESHOOTING – ALL YIG DRIVERS

NOTE Bias voltages and tuning currents for the oscillators are given on a data label on top of the A14 module.

Step No.	Symptom	Test Procedure (TP)	Result	Next Procedure
1	No RF output from yig oscillator in any band selected that provided an oscillator select to the yig driver.	1. Check tuning current at yig driver TP4 by measuring the voltage and dividing the voltage as follows: S Band (2-4) E/5 C Band Yig (4-8) E/5 X Band Yig (8-12) E/2 Ku Band Yig (12-18) E/1	a. No tuning current. b. Tuning current is present and at approx. the value indicated by data sheet on top of power supply module A14. c. Tuning current is excessively high or low.	a. Go to Step 2. b. To to TP2. c. Go to Step 5
		2. Check bias voltage at pin 14A of yig driver (pin 14A of A7 for S band driver) (correct bias voltages are indicated on data sheet on top of A14).	a. No bias voltage. b. Bias voltage ok.	a. Go to Step 11. b. Go to TP3.
		3. Check that pin current in the channel of the 5 pole is correct for the oscillator being troubleshot per Figure 3-3.	a. Pin current is incorrect per Figure 3-3. b. Pin current is incorrect.	a. Troubleshoot PIN per Figure 3-3. b. Go to TP4.
		4. Check bias current to yig with clip on millimeter w/red wire to all except S band which is w/yellow.	a. No bias current. b. Bias current ok.	a. Replace yig and driver. b. Go to TP5.
		5. Check power directly out of yig with power meter and 20 dB attenuator.	a. No power output.	a. Replace yig oscillator and matched driver board.
2	No tuning current.	1. Check F1 and F2.	a. Fuses ok. b. Fuses open.	a. Replace U3. b. Replace F1 and F2.
3	F1 and F2 continue to open.	1. Check for short of pin 1A and 1B of yig driver to ground.	a. 1A and 1B not shorted to ground.	a. Correct cause of short circuit.
		2. Check continuity of feedback from pin 1A to R80 to ground and from R80 through R68 to pin Z of U3.	a. Feedback loop open. b. Feedback loop ok.	a. Correct open current condition. b. Check U3, Q16, Q17, R18 and Q19 and replace component.
		3. Check for shorted FET gate or shorted band select control transistor.	a. FET or transistor shorted.	a. Replace.
4	No RF output in only one band in which the yig is used (such as no RF only in 4-8 portion of the 2-8 band).	1. Check that tuning current is correct during the portion of the board that the oscillator is being tuned.	a. Tuning current excessive high or low. b. Tuning current ok.	a. Replace bad gate transistor or control transistor. b. Troubleshoot leveling loop.
5	Frequency high or low, only the S, C, X, or Ku band portion of all bands (Example) (that is 12-18 portion of 8-18; 12-18 portion and of 2-18 band).	1. Remove FM drive A2.	a. Frequency is correct. b. No change.	a. Troubleshoot FM drive per Figure 3-7. b. Go to TP2.
		2. Check voltage at TP3.	a. Voltage is >0.3V from 0. b. Voltage is 0 ±0.3V.	a. Replace U2 or TC diode on yig heatsink. b. Go to TP3.
		3. Check Q4 and Q8.	a. Transistors shorted. b. Transistors ok.	a. Replace. b. Go to TP4.
		4. Check C11 thru C16 and C9 by turning 6600 ΔF and manual sweep control FCCW switch between Cw and ΔF mode of operation.	a. Frequency shifts greater than 1 MHz.	a. Replace leaky cap.
6	Frequency is okay in one band, but extremely high in all other (Example frequency is high or low in 8-12 portion of 8-18 band and 8-12 portion of 2-18 band but ok in 8-12 portion of the 4-12 band).	1. Check for shorted or open FET gates or shorted control transistors that control the band in which the frequency is ok. (Don't forget ground balance FETs also).	a. Shorted or open FET or transistor.	a. Replace shorted component.
7	Leveled output appears as a straight line at 10 ms sweep speed, but ok at 1 sec sweep speeds in all sections of all bands pertaining to the yig driver.	1. Check Q15.	a. Shorted Q15.	a. Replace
8	Leveled output is straight line and frequency is not changing.	1. Check oscillator select to yig driver.	a. Oscilloator select not present. b. Oscillator select ok.	a. Troubleshoot A6 per Figure 3-10. b. Go to TP2.
		2. Check control transistor for the oscillator select.	a. Open transistor or E B short.	a. Replace transistor.
9	Excessive line related FM.	1. Check K1 and Q15.	a. K1 or Q15 open. b. K1 or Q15 ok.	a. Replace. b. Troubleshoot 6600.
10	Excessive FM (jitter)			a. Replace U13 (use only low noise op. amp.)
11	No bias voltage.	1. Check F3.	a. F3 ok. b. F3 open.	a. Go to TP2. b. Replace.
		2. Check CR15	a. CR15 shorted (indicates an overvoltage has occured) b. CR15 ok.	a. Remove w/red lead from associated yig and replace CR15; troubleshoot supply and replace U4, Q23, Q25, Q22, or Q24. b. Go to TP3.
		3. Check C20.	a. C20 shorted. b. C20 ok.	a. Replace. b. Go to TP4.
		4. Check bias current with clip on milliameter at bias lead at yig oscillator.	a. Bias current greater than specified on data sheet and folds back bias supply.	a. Replace yig oscillator and driver.

FREQUENCY ADJUSTMENTS

Band	Reference	Dial Frequency	Actual Output Frequency	Adjustment
2-8 GHz	4-16	4.1 GHz	4.09 GHz ±5 MHz	A9R34
			8.00 GHz ±10 MHz	A9R12
Since the R34 and R12 controls interact, repeat both adjustments several times, until both output frequencies are within tolerances (typically 3 times). Do the R31, R15, R37 and R9 adjustments in the sequence indicated.				
4-12 GHz	4-16	4.0 GHz	4.00 GHz ±10 MHz	A9R31
		7.9 GHz	7.9100 GHz ±10 MHz	A9R15
2-18 GHz	4-16	4.1 GHz	4.09 GHz ±10 MHz	A9R37
		7.9 GHz	7.910 GHz ±10 MHz	A9R9
Since the R37 and R9 controls interact repeat both adjustments several times, until both output frequencies are within tolerances (typically 3 times).				


TOP VIEW
A9 YIG BOARD
R90 – OSC OVER VOLTAGE ADJUST
R93 – OSC BIAS VOLTAGE ADJUST
R9 – 7.9 GHz (2-18)
R12 – 8.0 GHz (2-8)
R15 – 7.9 GHz (4-12)
R31 – 4.0 GHz (4-12)
TP3
R49 – TEMP COMP
TP2
R48 – TEMP COMP BALANCE
(2-16) R37 – 4.1 GHz
(2-8) R34 – 4.1 GHz

COMPONENT SIDE

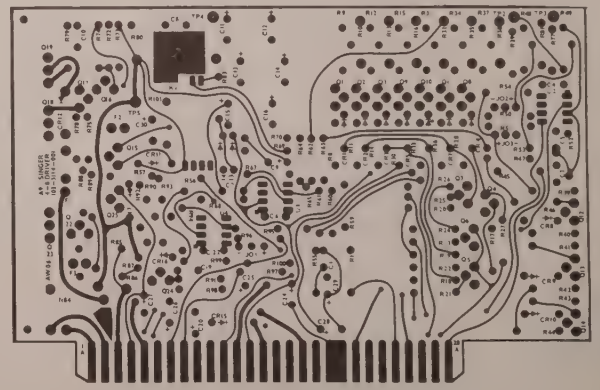
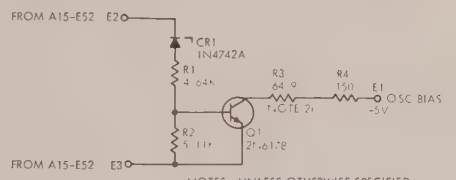

COMPONENT SIDE

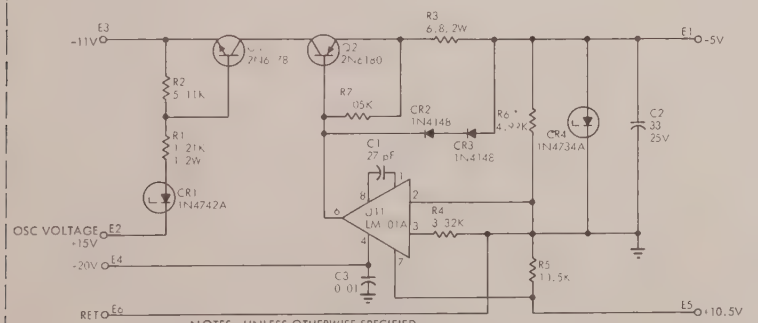
Figure 3-16. YIG Driver A9 (4-8 GHz) – Schematic Diagram (106-0817-001), Assembly Drawing (103-3114-001); Interlock A16 – Schematic Diagram (106-0855-001), Assembly Drawing (103-2202-001); Block/Circuit Analysis; and Adjustment/Troubleshooting Data (Sheet 1 of 2)

A16 – INTERLOCK A



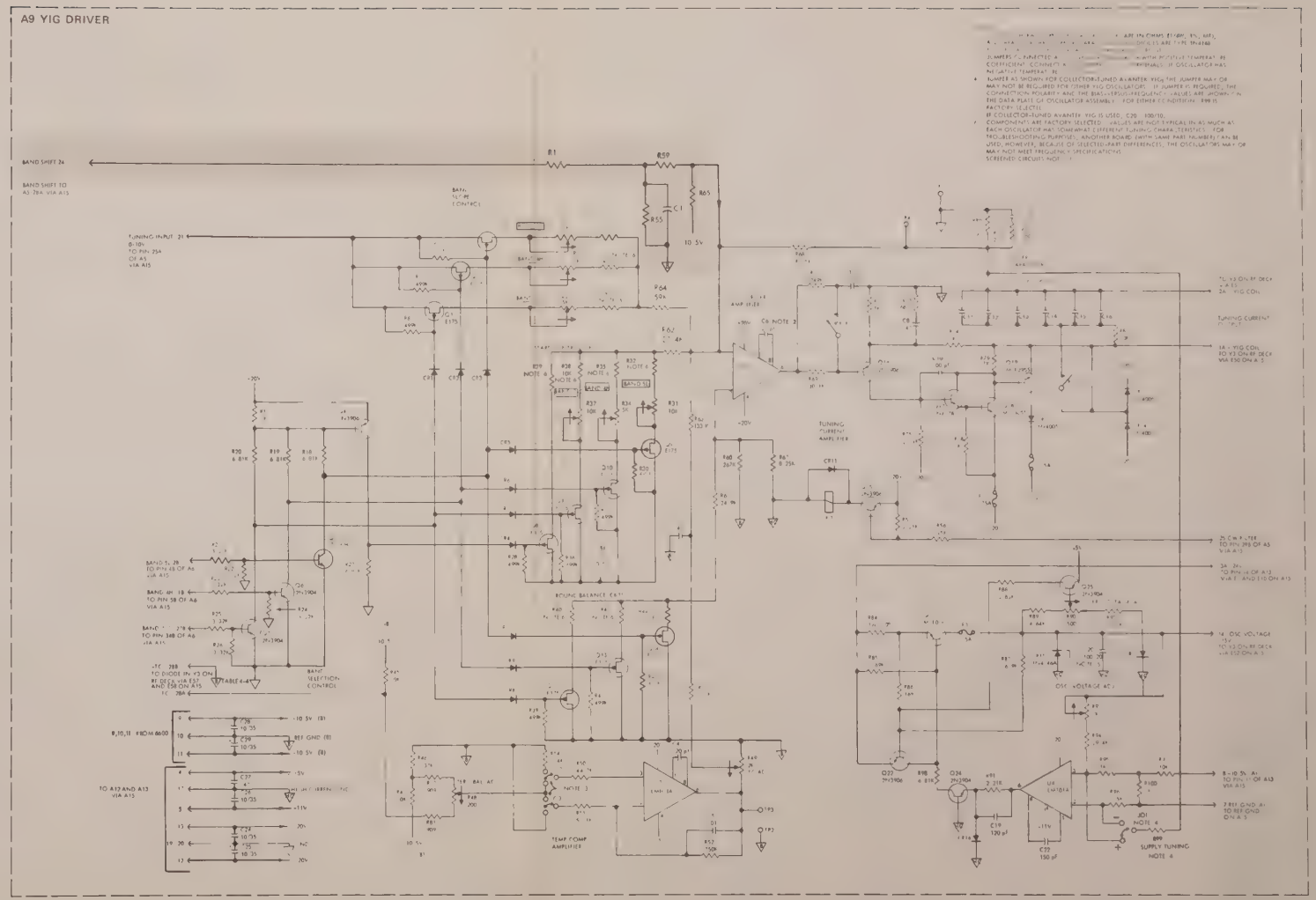
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS (1/4W, 1%, MF)
2. FACTORY SELECTED, TYPICAL VALUE SHOWN

A16 – INTERLOCK B



NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS (1/4, 1%, MF)
2. FACTORY SELECTED, TYPICAL VALUE SHOWN

A9 YIG DRIVER



CIRCUIT ANALYSIS – A16

The -5V for the 4–8 GHz YIG oscillator is furnished by a voltage divider from the -11V supply consisting of Q1, R3 and R4. The bias (collector) voltage, which is changed from 10V at 4 GHz to 15V at 8 GHz by the 4–8 YIG driver when the Avantec YIG requiring collector tuning is used, forward biases Q1. If the bias voltage is removed, Q1 stops conducting, removing the -5V from the YIG. R4 is selected for proper YIG operating current, approximately 30 to 40 ma maximum.

In later instruments, A16, in addition to the interlock function, serves as a fully regulated power supply. Transistor Q2 is a series regulator whose output is compared by U1 against the +10.5V reference supply to provide a regulat -5V at terminal E1. Diode CR4 provides overvoltage pro tection and R3 with CR2/CR3 provides current limiting a approximately 150 milliamperes. Transistor Q1 and CR1 provide an interlock so that if the +15V supply (A7) goes 0V, Q1 stops conducting, thus, removing -5V from the 4–8 GHz YIG.

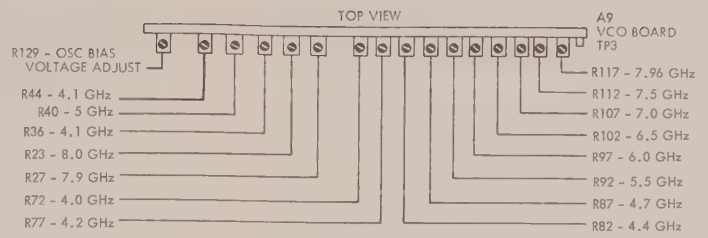
CIRCUIT ANALYSIS – A9

(Refer to Figure 3-16.)

Figure 3-16. YIG Driver A9 (4-8 GHz) – Schematic Diagram (106-0817-001), Assembly Drawing (103-3114-001); Interlock A16 – Schematic Diagram (106-0855-001), Assembly Drawing (103-2202-001); Block/Circuit Analysis, and Adjustment/Troubleshooting Data (Sheet 2 of 2)

TROUBLESHOOTING – COMMON TO ALL YIG DRIVERS

Step No	Symptom	Test Procedure (TP)	Result	Next Procedure
1	No RF output in the 4–8 GHz section of any band.	1. Check +15V bias at +15V terminal of VCO.	a. No +15V	a. Go to Step 2.
			b. +15V OK.	b. Go to TP2.
		2. Check pin current for 4–8 GHz port of 4 pole pin per Figure 3-3.	a. Pin current is not correct.	a. Troubleshoot A4 per Figure 3-3.
		3. Check tuning voltage at A9 TP3 is +3V at 4 GHz and –40 at 8 GHz.	a. Tuning voltage is –60 and does not change with input ramp.	a. Troubleshoot CR8, Q14 and Q15, replace faulty components.
			b. Tuning voltage is +10V and does not change with ramp input.	b. Troubleshoot Q13 and CR10 and replace faulty components.
			c. No–62V applied to A9.	c. Troubleshoot 6600 –62V supply.
			d. Tuning voltage OK.	d. Go to TP4.
		4. Check +15V current with clip-on milliammeter. Should be +200 to +250 ma.	a. Too high or too low.	a. Replace VCO and driver.
			b. Current OK.	b. Go to TP5.
		5. Check RF directly out of VCO with 20 dB attenuator and power meter or detector.	a. No RF power.	a. Replace VCO and driver.
			b. RF power OK.	b. Troubleshoot RF signal flow to front panel output.
2	No +15V bias.	1. Check for shorted C3 across bias terminal and ground at VCO.	a. C3 shorted.	a. Replace.
			b. C3 OK.	b. Go to next step.
		2. Check A9CR23.	a. CR23 shorted.	a. If CR23 is shorted, this indicates an over voltage condition has occured. Troubleshoot Q23, Q27, Q29 and U4 by removing +15V lead from VCO and attaching a 60 load resistor from the +15V lead to ground.
			b. CR23 OK.	b. Go to TP3.
		3. Check A9C12.	a. C12 shorted.	a. Replace.
			b. C12 OK.	b. Go to TP4.
		4. Check A9, Q27, Q23, Q29 and U4.	a. One or more components bad.	a. Replace faulty components.
3	Frequency excessively high or low in 4–8 GHz section of all bands.	1. Check A9, Q4 and A9 Q8.	a. Shorted or open component.	a. Replace.
			b. Q4 and Q8 OK.	b. Go to TP2.
		2. Check FM amp A9U3.	a. FM amp output + or – 15V with no input.	a. Replace U3.
			b. FM amp OK.	b. Go to TP3.
		3. Check linearization network A9Q16 through A9Q25.	a. Faulty components in network.	a. Replace.
4	Frequency OK in 4–8 section of one band, but high or low in all others.	1. Check FET gates and control transistor for the 4–8 band in which the frequency is OK.	a. Open or shorted component.	a. Replace faulty component.
5	Frequency is nonlinear.	1. Check cardinal points on 4–8 section of 4–12 band.	a. Frequency nonlinear.	a. Adjust per calibration procedure.
			b. Frequency linear.	b. Go to TP2.
		2. Check linearity in other bands.	a. Frequency nonlinear in other band.	a. Adjust high and low end frequency adjust for band that is nonlinear per calibration and adjustment procedures.
6	Excessive residual FM only in 4–8 section of all bands.	1. Check A9K1 and A9Q26 and A9C11.	a. Open or shorted.	a. Replace

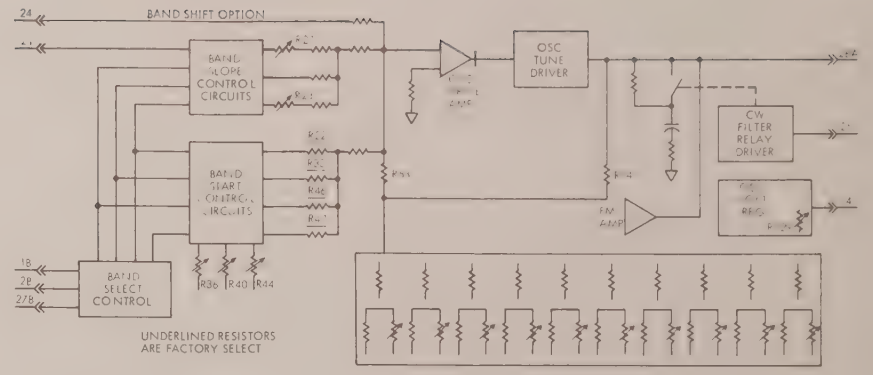


ADJUSTMENTS

Some 9515 oscillator units use a Varactor tuned 4–8 GHz oscillator. Due to the non-linearity of the tuning voltage versus frequency relationship of a varactor tuned oscillator, a linear circuit is used which requires several frequency adjustments within the 4–8 GHz band.

NOTE

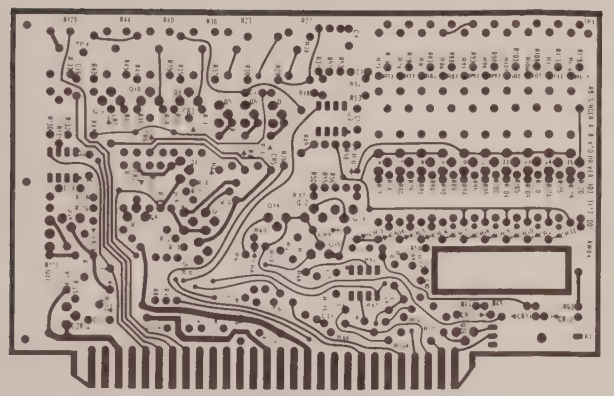
Before starting the frequency adjustments on this Varactor tuned oscillator, adjust A9R129 for +15.00V ±50 mV directly at the "+15V" terminal of the Varactor tuned oscillator.



Band	Reference	Dial Frequency	Actual Output Frequency*	Adjustment
4–12 GHz	4–15	5.0 GHz	5.00 GHz ±15 MHz	A9R40
		4.7 GHz	4.70 GHz ±15 MHz	A9R87
		4.4 GHz	4.40 GHz ±15 MHz	A9R82
		4.2 GHz	4.20 GHz ±15 MHz	A9R77
		4.0 GHz	3.99 GHz ±15 MHz	A9R72
		5.5 GHz	5.50 GHz ±20 MHz	A9R92
		6.0 GHz	6.00 GHz ±20 MHz	A9R97
		6.5 GHz	6.50 GHz ±20 MHz	A9R102
		7.0 GHz	7.00 GHz ±20 MHz	A9R107
		7.5 GHz	7.50 GHz ±20 MHz	A9R112
		7.9 GHz	7.9 GHz ±20 MHz	A9R117
2–8 GHz	4–15	4.1 GHz	4.09 GHz ±10 MHz	A9R36
		8.0 GHz	8.00 GHz ±10 MHz	A9R23
Since the R36 and R23 controls interact, repeat both adjustments several times until both output frequencies are within tolerances (typically 3 times).				
2–18 GHz	4–15	4.1 GHz 7.9 GHz	4.09 GHz ±10 MHz 7.915 GHz ±10 MHz	A9R44 A9R27
Since the R27 and R44 controls interact, repeat both adjustments several times until both output frequencies are within tolerances (typically 3 times).				

*These are the calibration frequencies used at the factor; each frequency is not necessarily marked on the dial.

Figure 3-17. VTO Driver A9 (4–8 GHz) – Schematic Diagram (106-0822-001), Assembly Drawing (103-3117-001), Block/Circuit Analysis, and Adjustment/Troubleshooting Data (Sheet 1 of 2)



COMPONENT SIDE

CIRCUIT ANALYSIS – A9

The VTO driver, A9, controls the frequency sweep of the 4–8 GHz voltage controlled oscillator.

The tuning input voltage ramp is turned ON and OFF by FET's Q5, Q6 and Q7. Rate of voltage increase at the output to the oscillator is determined by controls R23, R27 and R29. Starting voltage of the ramp is determined by R36, R40 and R44, starting voltage being turned on by FET's Q9, Q10 and Q11. Q1, Q2 and Q3 control the FET switches, which are cut OFF by positive voltages on their gates. If Q1, Q2 and Q3 are cut OFF by ground potentials at pins 1B, 2B and 27B of the A9 connector, all of the FET's except Q8 are cut OFF. Q8 supplies a steady voltage to hold the oscillator at the low frequency end of the band. When Q1, Q2 or Q3 conducts, its collector current compes partly from the base of Q4. This turns ON Q4 so that FE Q8 is cut OFF by a positive voltage at the gate, and the proper sweep starting voltage is supplied by Q9, Q10 or Q11.

Currents through the FET's are converted into proper voltages at the output to the oscillator by operational amplifier U2, impedance changer Q12, emitter follower Q15 and two constant current supplies, Q13 and Q14. CR9, CR11 and CR12 are protective diodes; they do not normally carry any current. Negative feedback from the output of pin 2 of U2 goes back through R54, is partly shunted to +10.5 volts and –10.5 volts by the tuning voltage shaping circuit and is then fed back through R53. A steady bias current is then fed back through R53. A steady bias current is fed through R51 and R52 from –10.5 volts.

If the voltage at pin 2 of U2 if more than about 2 millivolts from ground, pin 6 of U2 will be at one of the supply voltages, +20 or –11. Feedback through R53 is negative so voltage at pin 2 is held close to ground, and the sum of all currents to that point must be zero. This means that the voltage at pin 6 is directly proportional to the sum of the currents through R32, R31 and R48, but of opposite polarity, and affected by the currents to and from the tuning voltages shaping circuit.

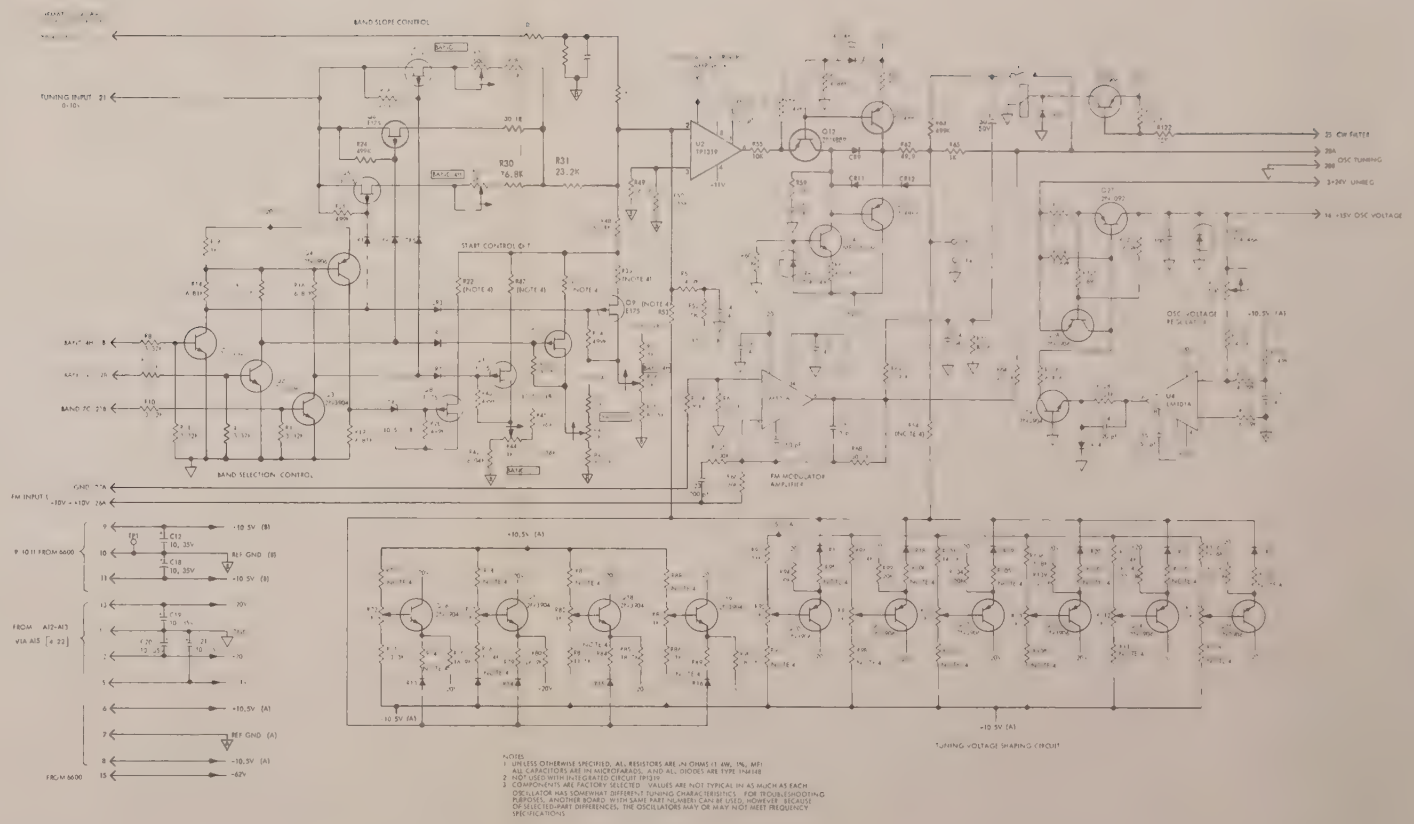
As an example of how the shaping circuit operates, see Q21, in the middle of the shaping circuit. The currents to pin 2 of U2 from the gating FET's form a negative going linear ramp. This means a positive going linear ramp at pin 6 of U2, with the current through R53 adding to the other currents into and out of pin 2 to form a net current of zero.

Without the shaping circuit, feedback current is proportional to output voltage, so the output is a linear ramp. With the shaping circuit, however, if output voltage is low, current flows through CR17 and R95 determines how much current flows. The emitter of Q20 is held at an essentially constant voltage by the voltage on the base of Q20, which is set by R92. Hence voltage across R95 varies as the tuning ramp voltage changes. Changing output voltage causes changing current in R95, hence less current change in R53 than would occur if R95 drew no current. Hence rate of voltage change at the output is greater than for non-shunted feedback. When the voltage at the anode of CR17 reaches the voltage at the emitter of Q20, current through CR17 stops and does not resume until the ramp voltage goes back negative. At this point, ignoring all other shunt paths, the rate of voltage change becomes what it would be for a non-shunted feedback.

Each of the ten shunt circuits has an adjusting potentiometer for setting voltage when current starts or stops. Each has a factory-selected resistor, like R95, which determines current, hence output voltage rate of change. These shunts allow the shape of the output voltage ramp to match the tuning characteristics of the voltage controlled oscillator.

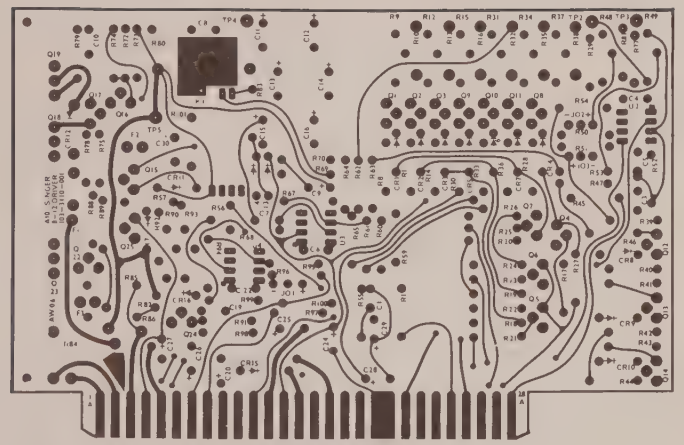
FM is provided by U3. The FM input signal from pin 26A of the A9 connector is amplified by 1.5 between the input at pin 26A and pin 6 of U3. For a ±10 volt input, output is ±15 volts.

U4 compares oscillator voltage at pin 14 of the A9 connector with a –10.5 volt reference. Output of U4 is fed through Q29 to the series regulator Q27, which therefore holds output voltage to a value set by R129. Q28 limits current by reducing base current in Q27 if current through R23 is excessive. CR25, a Zener diode, protects the oscillator against excess voltage.



NOTES:
1. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE IN OHMS ±1 4W, 1%, MF.
2. ALL CAPACITORS ARE IN MICROFARADS, AND ALL DIODES ARE TYPE 1N4148.
3. NOT USED WITH INTEGRATED CIRCUIT FP37N.
4. COMPONENTS ARE FACTORY SELECTED. VALUES ARE NOT TYPICAL IN AS MUCH AS EACH OSCILLATOR HAS SOMEWHAT DIFFERENT TUNING CHARACTERISTICS. FOR TROUBLESHOOTING PURPOSES, ANOTHER BOARD WITH SAME PART NUMBERS CAN BE USED, HOWEVER BECAUSE OF SELECTED-PART DIFFERENCES, THE OSCILLATORS MAY OR MAY NOT MEET FREQUENCY SPECIFICATIONS.

Figure 3-17. VTO Driver A9 (4–8 GHz) – Schematic Diagram (106-0822-001), Assembly Drawing (103-3117-001), Block/Circuit Analysis, and Adjustment/Troubleshooting Data (Sheet 2 of 2)



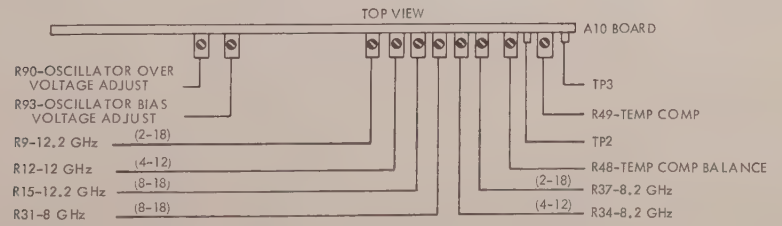
COMPONENT SIDE

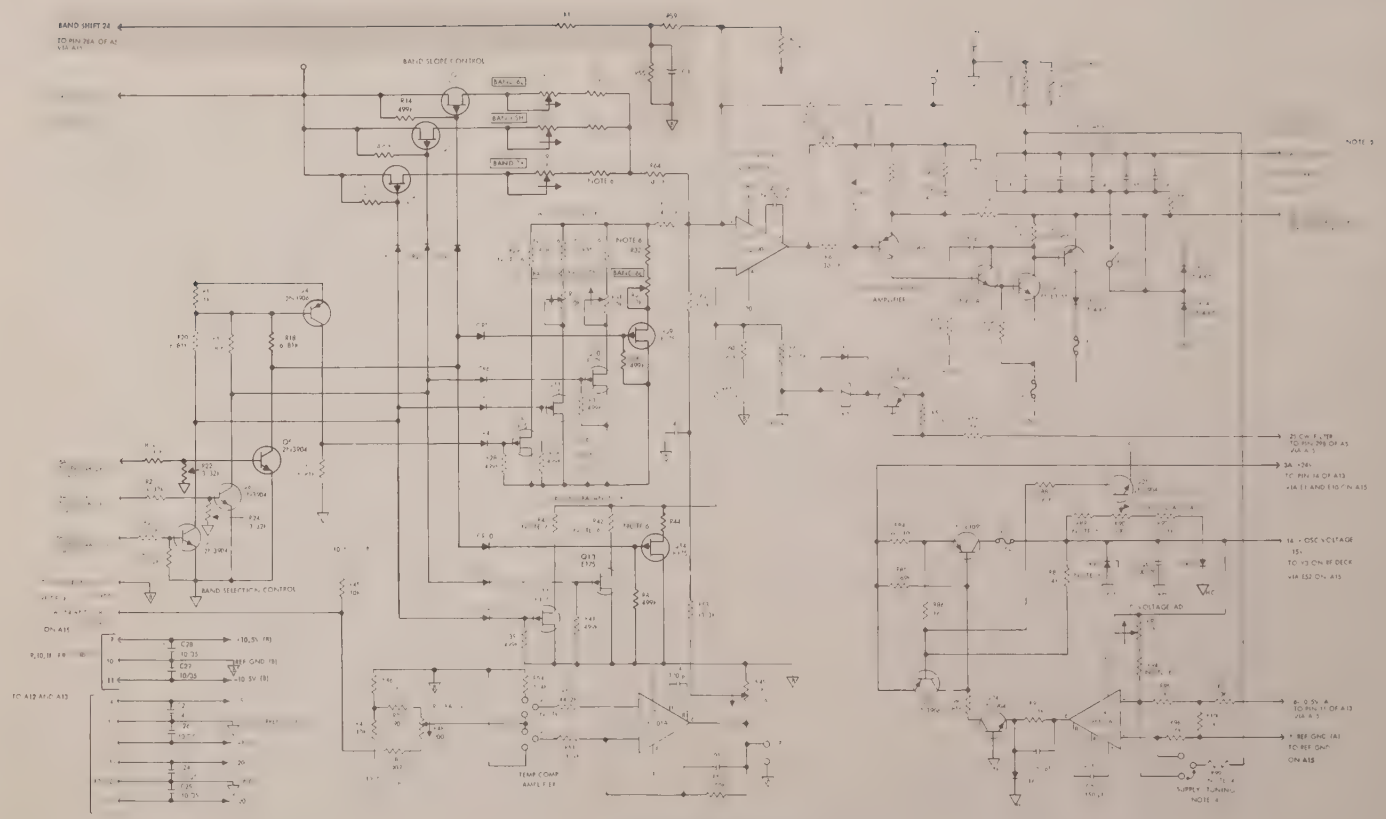
ADJUSTMENTS – YIG DRIVER A10

FREQUENCY ADJUSTMENTS

Band	Reference	Dial Frequency	Actual Output Frequency	Adjustment
4–12 GHz	4–17	8.2 GHz	8.190 GHz ±10 MHz	A10R34
		12.0 GHz	12.00 GHz ±20 MHz	A10R12
Since the R34 and R12 controls interact, repeat both adjustments several times, until both output frequencies are within tolerances (typically 3 times).				
8–18 GHz	4–17	8.0 GHz	8.00 GHz ±10 MHz	A10R31
		12.2 GHz	12.21 GHz ±10 MHz	A10R15
2–18 GHz	4–17	8.2 GHz	8.190 GHz ±10 MHz	A10R37
		12.2 GHz	12.2 GHz ±10 MHz	A10R9
Since the R37 and R9 controls interact, repeat both adjustments several times, until both output frequencies are within tolerances (typically 3 times).				

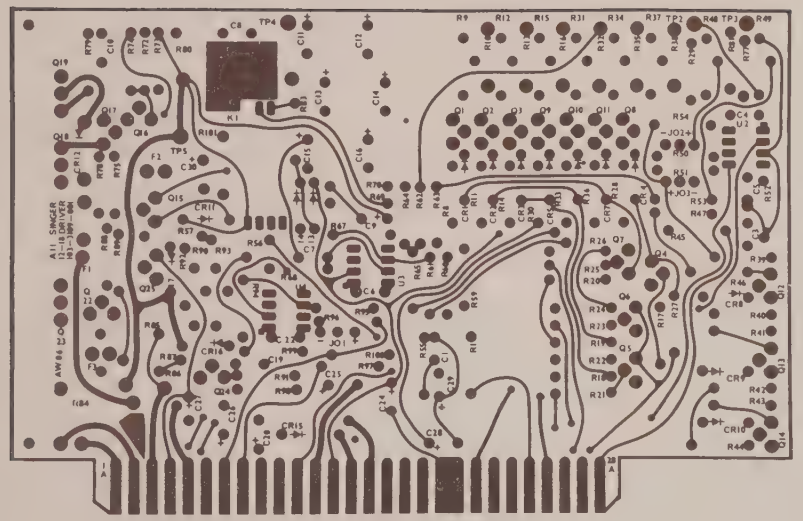
ADJUSTMENT LOCATIONS





CIRCUIT ANALYSIS – A10
(Refer to Figure 3-11.)
TROUBLESHOOTING – A10
(Refer to Figure 3-12.)

Figure 3-18. YIG Driver A10 (8–12 GHz) – Schematic Diagram (106-0818-001), Assembly Drawing (103-3110-001), Block/Circuit Analysis, and Adjustment/Troubleshooting Data

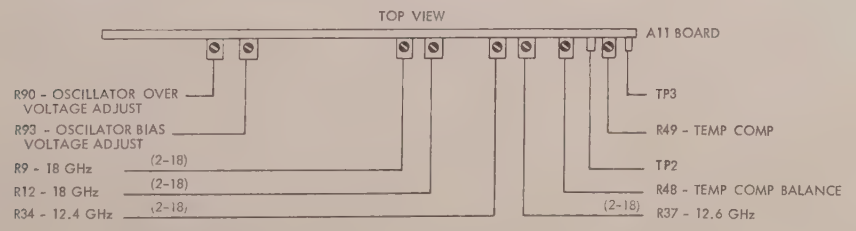


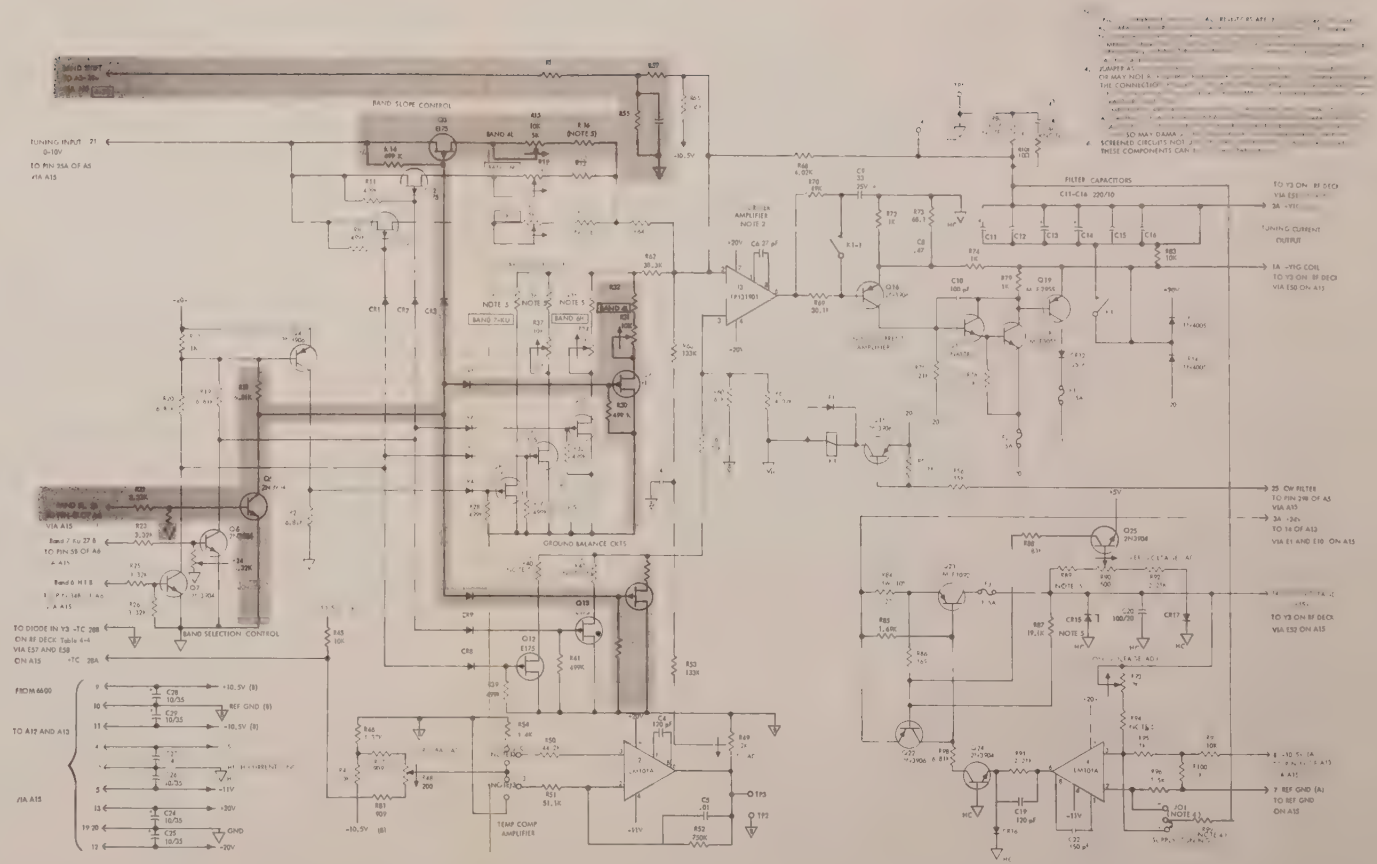
COMPONENT SIDE

FREQUENCY ADJUSTMENTS

Band	Reference	Dial Frequency	Actual Output Frequency	Adjustment
8–18 GHz	4–18	12.6 GHz	12.58 GHz ±10 MHz	A11R34
		18.0 GHz	18.00 GHz ±20 MHz	A11R12
Since the R34 and R12 controls interact, repeat both adjustments several times, until both output frequencies are within tolerances (typically 3 times).				
2–18 GHz	4–18	12.6 GHz	12.58 GHz ±10 MHz	A11R37
		18.0 GHz	18.00 GHz ±20 MHz	A11R9
Since the R37 and R9 controls interact, repeat both adjustments several times, until both output frequencies are within tolerances (typically 3 times).				

ADJUSTMENT LOCATIONS





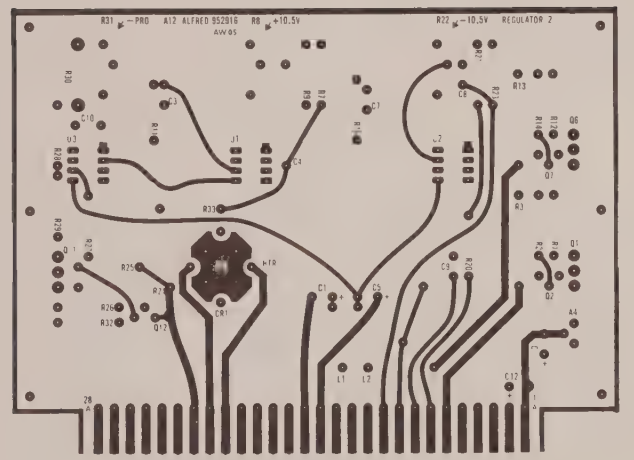
CIRCUIT ANALYSIS – A11

(Refer to Figure 3-11.)

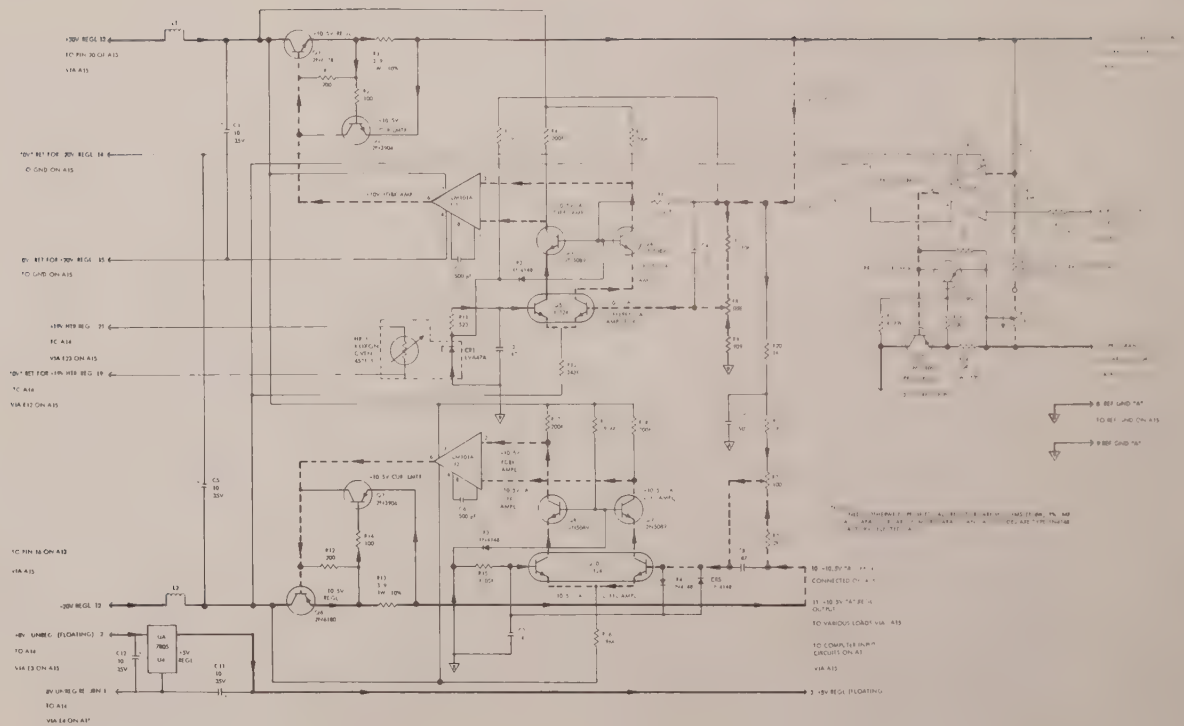
TROUBLESHOOTING – A11

(Refer to Figure 3-12.)

Figure 3-19. YIG Driver A11 (12–18 GHz) – Schematic Diagram (106-0819-001), Assembly Drawing (103-3109-001), Block/Circuit Analysis, and Adjustment/Troubleshooting Data



COMPONENT SIDE



DESCRIPTION:

A high-accuracy digital voltmeter is used to check the power supply voltages. They are then adjusted for the correct voltage. This procedure should be performed before any other adjustment and in the sequence described.

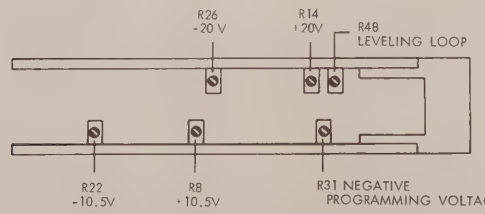
EQUIPMENT:

Digital Voltmeter . . . . . Fluke Model 8300A

PROCEDURE:

Push POWER switch "on". Let unit warm up for at least 15 minutes. Connect DVM between ground or reference potential and the test points shown in the following listing. For ground, any of the ground connections on the mother board A15 (for instance E21) is satisfactory. For reference potential for the +10.5V and –10.5V supplies, E30 is used.

DO NOT ADJUST R48 DURING POWER SUPPLY ADJUST PROCEDURE; IT IS ADJUSTED DURING LEVELING ADJUST PROCEDURE.



Adjustment Locations for Power Supply Voltages (A12, A13 Board)

SUPPLY VOLTAGES, TEST POINTS, VOLTAGE LEVELS, AND ADJUSTMENTS

Supply	Test Point	Voltage Level	Adjustment
+20 VDC –20 VDC +10.5 VDC –10.5 VDC Negative Programming	A15, E25 A15, E27 A15, E31 A15, E29 A15, E24	+20.0V ±50 mV –20.0V ±50 mV +10.5V ±5 mV –10.5V ±5 mV –4.7V nominal; actual value marked on top of power supply module.	A13R14 A13R26 A12R8 A12R22 A12R31

Power supply voltages which do not have adjustments but which depend on the adjustments of the above supplies are shown below. Check the voltage levels. They should be within the tolerances stated.

Supply	Test Point	Voltage Level
+19.5 VDC –11.0 VDC +5.0 VDC +5.0 VDC floating	A15, E28 A15, E32 A15, E34 A15, E12 Pin 3 Reference: A15, E2	+19.5V ±0.5V –11.0V ±0.1V +5.0V ±50 mV +5.0V ±0.4V

CIRCUIT ANALYSIS – A12

Assembly A12 has on it four voltage regulators. The +5 volt, floating regulator takes power from a transformer winding and bridge rectifier in the power supply module, A14. There are no connections to other circuits except the computer inputs on A1. Regulation is provided by an integrated circuit, U4, which gives an output of +5 volts ±1%.

The –Program Voltage Regulator balances the reference +10.5 volts against the –Program Voltage output to obtain ground potential plus or minus one or two millivolts on pin 2 of U3. R31 is used to determine the exact output voltage. U3 drives the base of series regulator Q11 to convert –13 volts unregulated to any chosen value between –12 volts and –2.5 volts, depending on R30 and R31. Transistor Q12 detects excess current flowing through R24 and reduces base current in Q11, thereby limiting current output to a safe value.

The +10.5 volt regulator provides the basic reference voltage for the 9515 instrument. Zener diode CR1 is mounted in a thermostatically controlled oven, HR-1. Rated voltage for CR1 is 4.7V ±5%, but the voltage is constant ±0.1% when the diode is held at constant temperature in the oven. The cascade push-pull amplifiers Q5, Q4 and Q3 compare feedback from the output voltage, via R8, with CR1 voltage. The amplified difference is fed to U1 and further amplified to drive the series regulator Q1. Output voltage is constant ±0.2% and is used as a reference voltage for other circuits. Q2 detects excess current flowing in R3 and reduces base current in Q1, thereby limiting output current to a safe value.

The –10.5 volt regulator operates like the +10.5 volt regulator except that the output voltage is balanced against the +10.5 volt reference voltage to give ground potential at the base of Q10 which is connected to R22. The other base is held at ground potential. As in the +10.5 volt regulators the push-pull amplifier drives U2, which drives the series regulator, Q6. Output voltage is constant within approximately ±0.5%.

Figure 3-20a. Regulator #2 Board A12 – Schematic Diagram (106-0814-001), Assembly Drawing (952916), Circuit Analysis and Adjustment Data

Step No.	Symptom	Test Procedure (TP)	Result	Next Procedure
1	All 9515 power supplies are low or zero except the +5 V floating.	1. Check +24V raw supply input to regulator at A13 pin 14.	a. Voltage not present.	a. Troubleshoot power supply Figure 3-18.
			b. Ok	b. Go to TP2.
		2. Check for short in +20V supply by removing A1-A4 and A6-A12 one at a time.	a. Power supply returns to normal when one of the boards is removed.	a. Check and/or replace input decoupling cap for the +20 input on the PCB that when removed, the supply returns to normal.
			b. +20V still low or zero V.	b. Go to TP3.
		3. Check C6 on Mother Board.	a. Is shorted	a. Replace C6.
			b. OK	b. Go to TP4
		4. Disconnect the red wire by going to the LF Deck by unplugging the wire pin connector on the upper microwave deck.	a. +20V returns to normal.	a. Replace LF Deck (the LF Deck is not field repairable).
			b. No change.	b. Go to TP5.
		5. Check voltage across A13 R2 (use DVM with floating input terminals).	a. Voltage is 0.	a. Replace Q1, Q3, or U1.
			b. Voltage is 7.5V (this check indicates there is current being drawn through the series regulator Q1).	b. Go to TP6.
		6. Check that the +19.4V supply is not shorted to ground (this supply is for the oven on A12, the lights on the front panel and the YIG heaters or S&C Band YIGs).	a. Is shorted to ground.	a. Correct short circuit condition and replace A13, Q14.
			b. No short.	b. Go to Step 2.
2	No +19V.	1. Check +20V.	a. No +20V.	a. Go to Step 1 Figure 3-12.
			b. +20V is ok.	b. Go to TP2.
		1. Check for short at output of +19V supply.	a. Shorted to ground.	a. Correct short circuit condition and replace A13, Q14.
3	No -20V.	1. Check +20V.	a. No +20V.	a. Go to Step 1.
			b. +20V is ok.	b. Go to TP2.
		2. Check -24 unregulated at A13 pin 13.	a. No -24V.	a. Go to Figure 3-18.
			b. -24V ok.	b. Go to TP3.
		3. Check voltage drop across A13, R16 (use DVM with floating input terminals.	a. Voltage is ok.	a. Check A13, Q4, Q5, Q20 and U2 and explore as necessary.
			b. Voltage is >.5V.	b. Go to TP4.

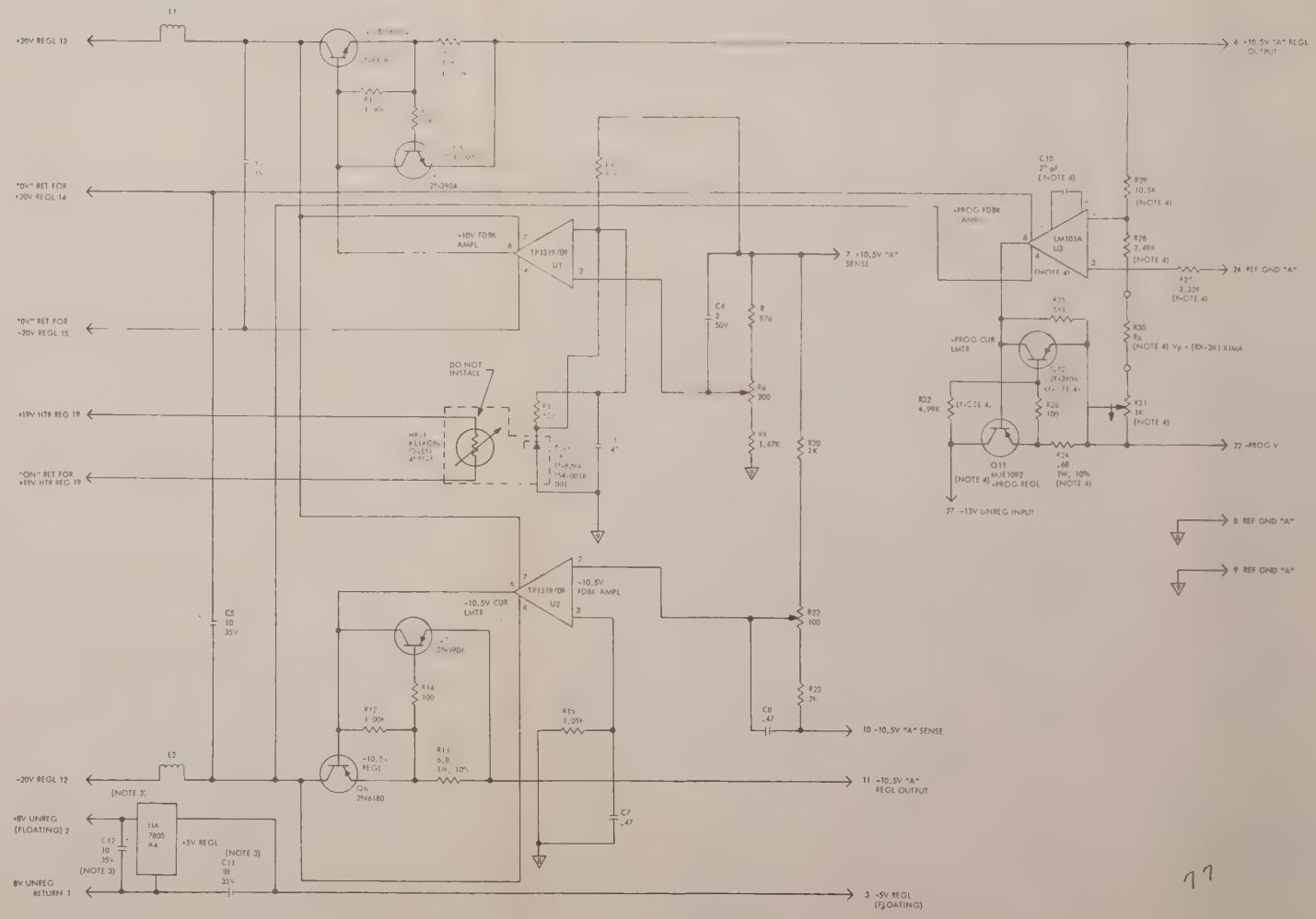
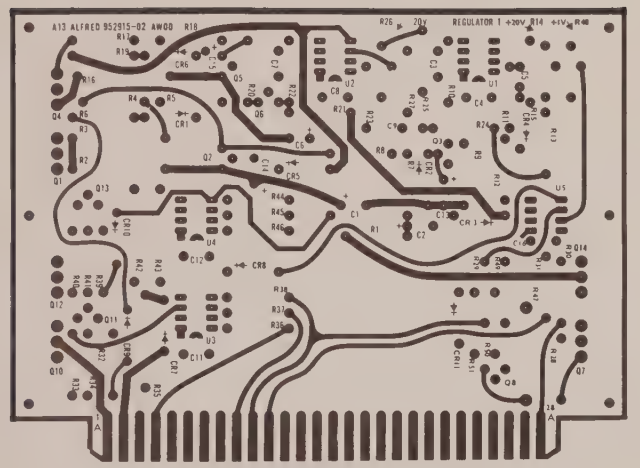


Figure 3-20b. Regulator #2 Board A12 – Schematic Diagram (106-0814-002), Assembly Drawing (952916), Block Diagram and Troubleshooting



COMPONENT SIDE

CIRCUIT ANALYSIS – A13

The A13 Assembly contains 5 voltage regulators; the +20 volt regulator supplies constant voltage for most of the circuits in the 9515. The power supply, A14, generates +24V unregulated, which is fed to the emitter of series regulator Q1, via R2 and R4. Output voltage, from the collector of Q1 is fed back through R13 and R14 to pin 3 of U1. Pin 2 of U1 is held at +6.2 volts by zener diode CR4. R14 can be adjusted so that +6.2 volts appears at pin 3 of U1 when +20.0 volts is the output voltage.

Integrated Circuit U1 amplifies any error signal. Q3 changes the low impedance output of U1 to a high impedance drive for the base of Q1. Zener Diode CR2 holds the base of Q3 at +15 volts to allow a true current drive for Q1. The negative feedback loop has enough gain to hold the output at +20.0 volts plus or minus less than 1 percent.

Excess current through R2 and R4 turns on Q2 which bypasses the current for the base of Q1, thereby limiting output current to a safe value. If an overload drops the limited current output voltage below 6 volts, CR1, and 18 volt zener diode, conducts and draws current from the base of Q2. Q2 further bypasses the current in the base of Q1, and output voltage and current drop to zero except for one half milliampere through CR1. Operation is restored by cutting off primary power.

Operation of the -20 volt regulator is the same as that for the +20 volt regulator except that polarities are reversed, and reference voltage is +20 volts, regulated. This is balanced against output voltage to give zero volts from R26, while pin 2 of U2 is connected to ground potential.

The +1 volt regulator uses -10.5V for reference, balancing it against the +1 volt output to give zero volts output of R48 to pin 2 of U5. Pin 3 is connected to ground. Output of U5 drives the series regulator Q7, directly to hold the output at +1.0V. Excess current through R47 turns on Q8 to bypass the base current of Q7, thereby limiting output current. R48 is adjusted for approximately +1 volt during linearization of the 4 pole PIN driver.

The +5 volts Regulator uses +10.5 volts as reference, with voltage divider R37 and R38 putting +5 volts on pin 3 of U3. Output voltage is fed through R37 to pin 2 of U3. Any unbalance is amplified by U3 and goes to the base of the series regulator Q10. Output voltage is held at +5.0 volts ±1 percent. Q11 detects excess current through R35 and bypasses base current for Q10, limiting output current. Diode CR9, a 15 volt zener, supplies current to the base of Q11 if output voltage drops appreciably below +5 volts. Q11 bypasses base current to Q10 and output current and voltage drop to zero except for approximately 8 mA through CR9. Operation is restored by removing primary power.

The -11 volt regulator uses +10.5 volts for reference and balances it against output voltage to put ground potential on pin 2 of U4. Pin 3 is connected to ground through R45. Any error signal is amplified by U4 and drives series regulator Q12, to hold output voltage at -11 volts ±1 percent. Excess current through R42 and R3 is detected by Q13 which then bypasses base current for Q12 and limits output current. If output voltage drops to less than -8 volts, CR10, a 12 volt zener, conducts and supplies current for the base of Q13. Q13 bypasses current from the Q12 base, reducing output current and both current and voltage at the output drop to zero, except for current of approximately 8 mA through CR10. Operation is restored by removing primary power.

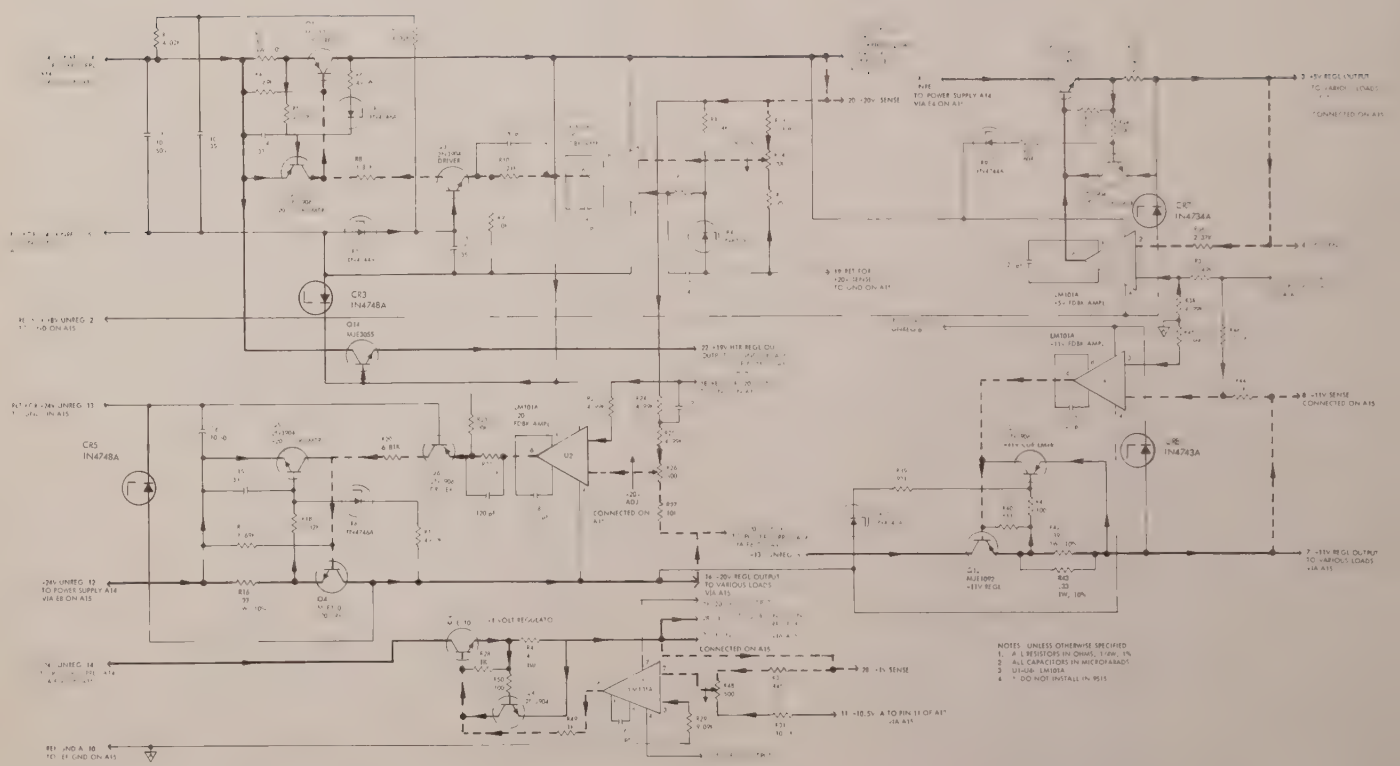
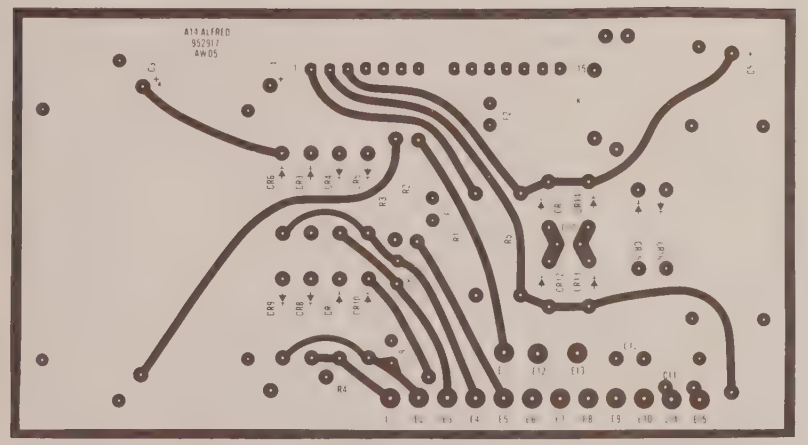


Figure 3-21. Regulator #1 Board A13 – Schematic Diagram (106-0813-002), Assembly Drawing (944448), and Circuit Analysis



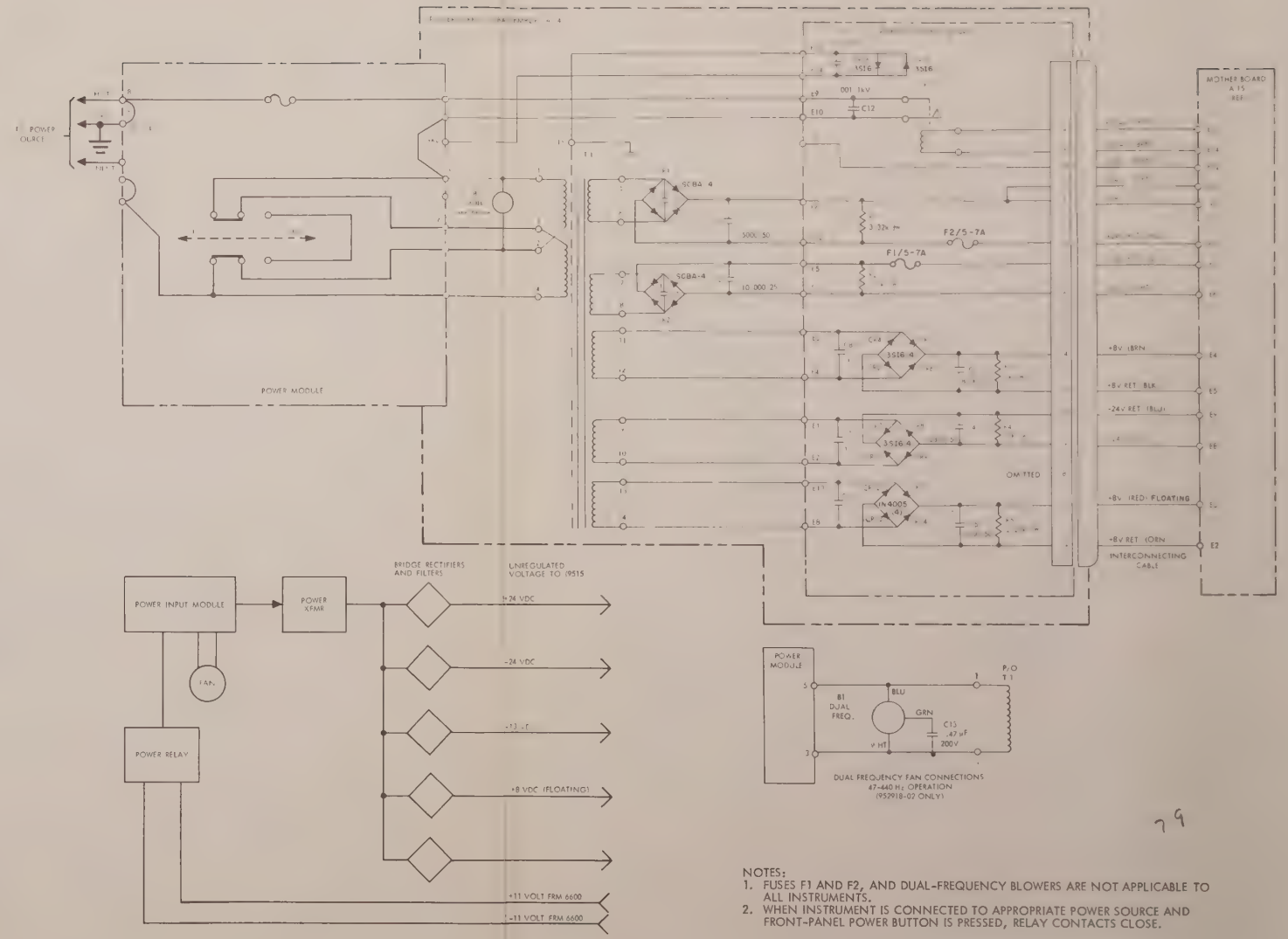
COMPONENT SIDE

CIRCUIT ANALYSIS – A14

The Power Supply Assembly, A14, consists of a transformer, 5 rectifier bridges with output capacitors and drain resistors, a power relay for remote turn-on, a cooling fan, and a power input module. All output connections are to E Terminals on A15, the mother board.

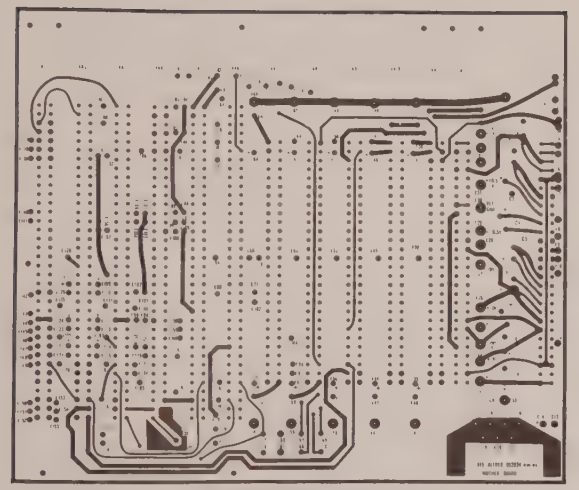
TROUBLESHOOTING – A14

Step No.	Symptom	Test Procedure (TP)	Result	Next Procedure
1	Fan not operating no output voltage.	1. Check line cord, fuse and connection to 6600/9514.	a. Open fuse or line cord, improper connection to 6600/9514.	a. Correct improper condition.
			b. Ok	b. Go to TP2.
		2. Check the ±11 VDC at E14 and E13.	a. One or more voltage incorrect.	a. Troubleshoot 6600 ± program supplies.
			b. Ok	b. Go to TP3.
		3. Remove A14 from the 9515 and remove the top cover, check that K1 is closing and that there is continuity between the switching contacts.	a. Relay is open at all times.	a. Replace relay.
			b. Ok	b. Go to Step 2.
2	One or more voltage missing.	Check voltage outputs at Mother Board test points.	a. One or more voltage missing (voltages are normally 10 to 50 percent higher than indicated on schematic depending on the line voltage and load)	a. Repair associated rectifier bridge.

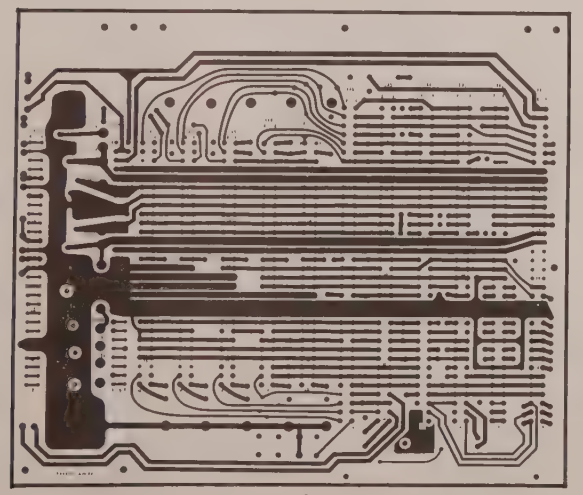


NOTES:
1. FUSES F1 AND F2, AND DUAL-FREQUENCY BLOWERS ARE NOT APPLICABLE TO ALL INSTRUMENTS.
2. WHEN INSTRUMENT IS CONNECTED TO APPROPRIATE POWER SOURCE AND FRONT-PANEL POWER BUTTON IS PRESSED, RELAY CONTACTS CLOSE.

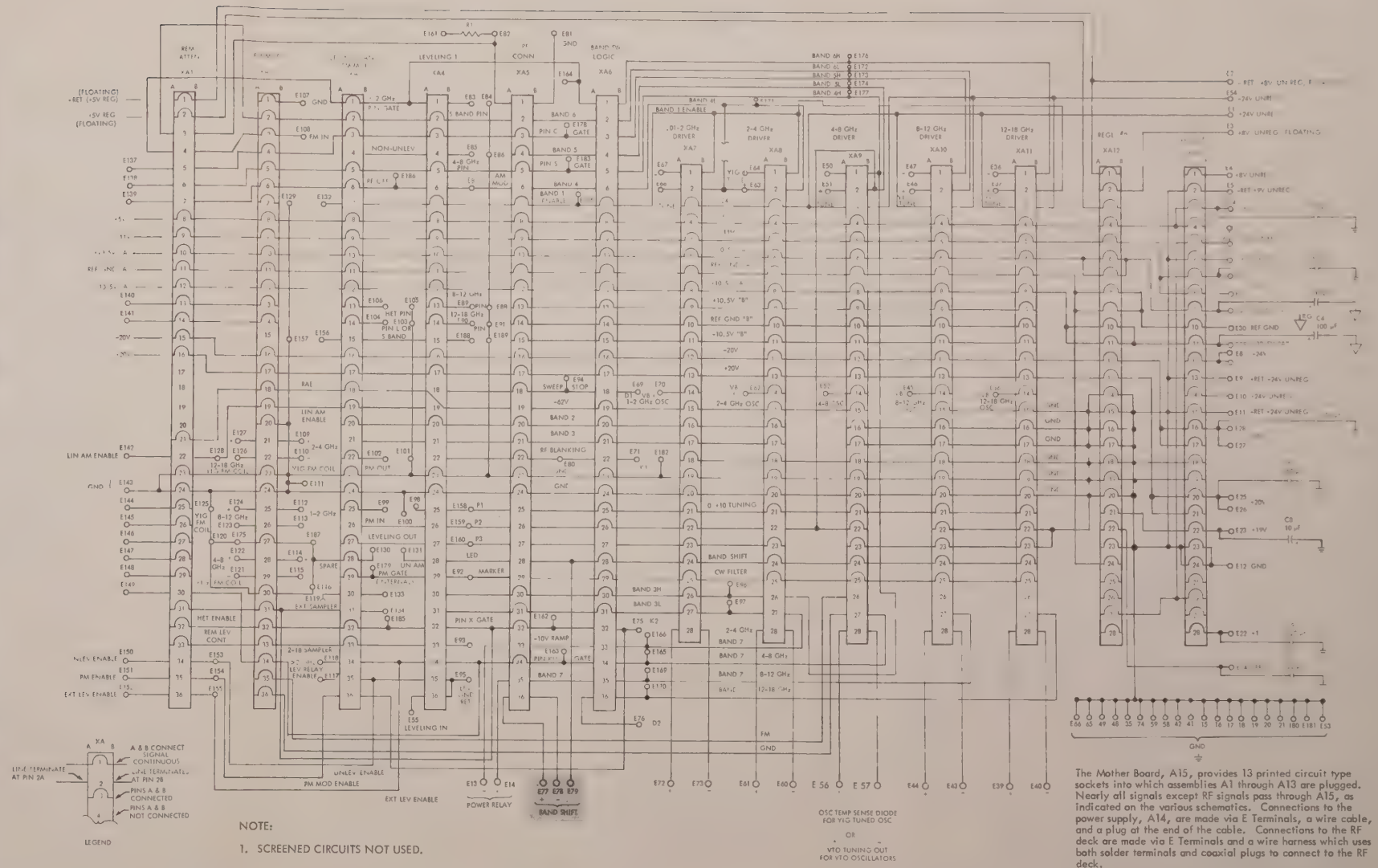
Figure 3-22. Power Supply Board A14 – Schematic Diagram (106-0849-001), Assembly Drawing (952917), Block/Circuit Analysis, and Troubleshooting Data



COMPONENT SIDE

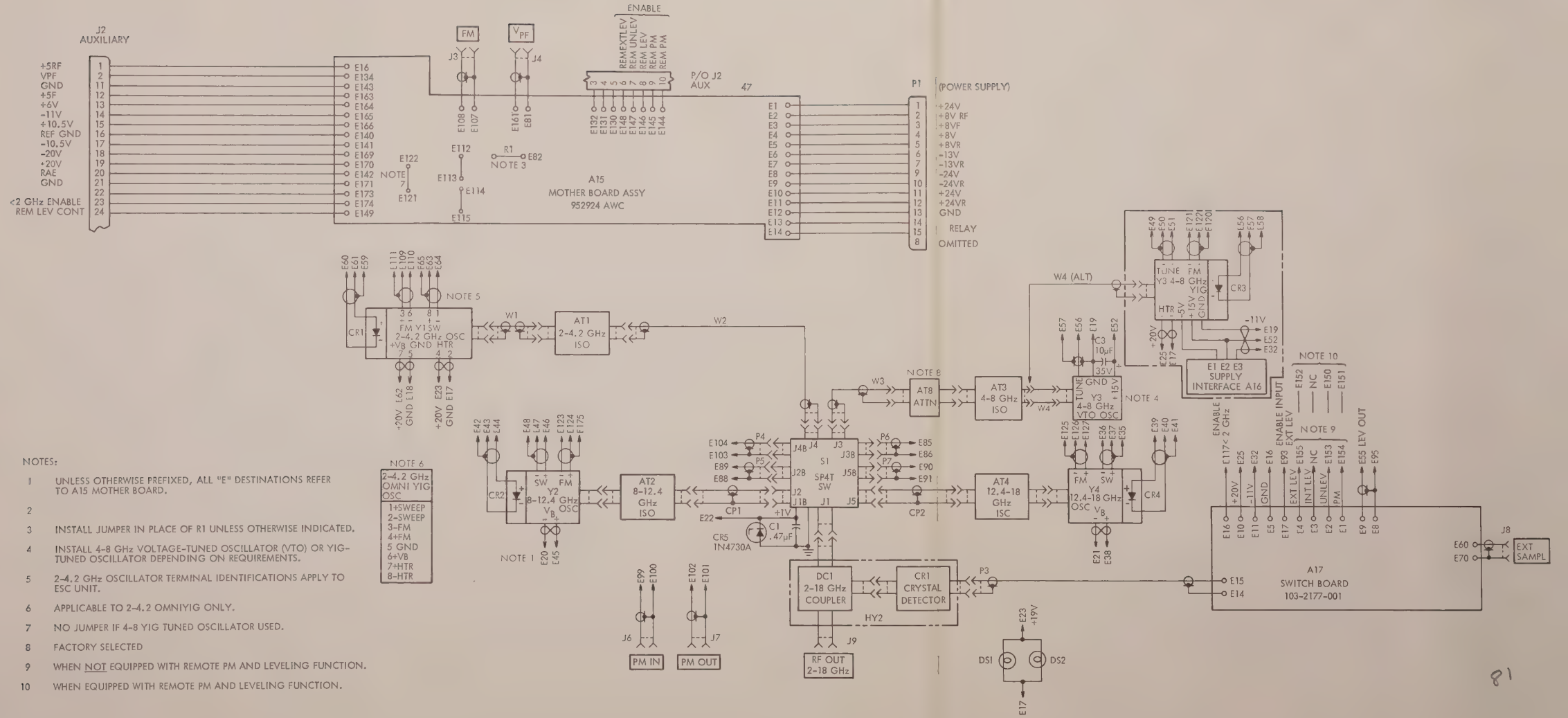


CIRCUIT SIDE


A & B CONNECT SIGNAL CONTINUOUS
LINE TERMINATE AT PIN 2A
LINE TERMINATE AT PIN 2B
PINS A & B CONNECTED
PINS A & B NOT CONNECTED
LEGEND
NOTE:
1. SCREENED CIRCUITS NOT USED.
OSC TEMP SENSE DIODE FOR YIG TUNED OSC
OR
VTO TUNING OUT FOR VTO OSCILLATORS

The Mother Board, A15, provides 13 printed circuit type sockets into which assemblies A1 through A13 are plugged. Nearly all signals pass through A15, as indicated on the various schematics. Connections to the power supply, A14, are made via E Terminals, a wire cable, and a plug at the end of the cable. Connections to the RF deck are made via E Terminals and a wire harness which uses both solder terminals and coaxial plugs to connect to the RF deck.

Figure 3-23. Mother Board A15 – Schematic Diagram (106-0851-001), and Assembly Drawing (952924)



NOTES:

1. UNLESS OTHERWISE PREFIXED, ALL "E" DESTINATIONS REFER TO A15 MOTHER BOARD.
2.
3. INSTALL JUMPER IN PLACE OF R1 UNLESS OTHERWISE INDICATED.
4. INSTALL 4-8 GHz VOLTAGE-TUNED OSCILLATOR (VTO) OR YIG-TUNED OSCILLATOR DEPENDING ON REQUIREMENTS.
5. 2-4.2 GHz OSCILLATOR TERMINAL IDENTIFICATIONS APPLY TO ESC UNIT.
6. APPLICABLE TO 2-4.2 OMNIYIG ONLY.
7. NO JUMPER IF 4-8 YIG TUNED OSCILLATOR USED.
8. FACTORY SELECTED
9. WHEN NOT EQUIPPED WITH REMOTE PM AND LEVELING FUNCTION.
10. WHEN EQUIPPED WITH REMOTE PM AND LEVELING FUNCTION.

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Figure 3-24. RF Interconnection Diagram (2-18 GHz)

SECTION IV
PARTS LIST

4-1. INTRODUCTION

This parts list section includes all pertinent data necessary to locate, identify, and procure additional parts for the equipment. Parts are listed alphanumerically by reference symbol and include all replaceable electronic items. In some cases, values, ratings and manufacturer sources shown are nominal and variations may be found. Satisfactory replacement may be made with either the listed component or an exact replacement of the part(s) removed from the equipment.

4-2. ORDERING INFORMATION

The following instructions will aid in ordering parts from the parts list.

a. Address all inquiries or orders to:

CUSTOMER SERVICE
The Singer Company
5340 Alla Road
Los Angeles, California 90066

b. Include the following information:

1) Model and Serial Number of Instrument.
2) Singer Part Number.
3) Reference Symbol Number.
4) Description (as shown on Parts List).

4-3. HOW TO USE THE PARTS LIST

Paragraphs 4.3.1 through 4.3.5 describe the use and meaning of the five columns included in the Parts List. Table 4-1 lists the assemblies covered by the Parts List. Table 4-2 lists the manufacturer's code. Table 4-3 is a list of circuit reference symbols. Table 4-4 is a list of abbreviations used with this Parts List. Tables 4-5 through 4-27 lists parts used in the Model 9514B/9515B.

4.3.1 REFERENCE DESIGNATION, COLUMN 1

The Reference Designation Column contains an alphanumeric listing of parts as they appear on the equipment chassis, illustration, or schematic. The reference designation identifies the parts as to their component function in the instrument.

4.3.2 SINGER PART NUMBER, COLUMN 2

The Singer Part Number column contains the part number designated by The Singer Company.

4.3.3 DESCRIPTION, COLUMN 3

The Description column contains the identification of component parts, including all pertinent specifications. When the description column is used for a reference symbol for which no part exists, "NOT ASSIGNED" is placed in the column. In these instances, columns 2, 4, and 5 are left blank.

4.3.4 MANUFACTURER'S CODE NUMBER, COLUMN 4

The Manufacturer's Code Number column references the manufacturer by an assigned code number, as listed in Federal Supply Code Handbook H4-2. For manufacturers not listed in the Handbook, a letter code will be assigned. Table 4-2 includes the manufacturer and his code designation.

4.3.5 MANUFACTURER'S PART NUMBER, COLUMN 5

The Manufacturer's Part Number shown contains the part number as designated by the manufacturer of the part.

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TABLE 4-1. PARTS LIST BY ASSEMBLY NUMBER

TABLE	CIRCUIT REFERENCE	ASSEMBLY DESCRIPTION
4-5	9514	Controller
4-9	A1	Remote Level
4-10	A2	FM Modulator
4-11	A3	PM and Leveler #2
4-12	A4	Leveler #1
4-13	A5	Connector Assembly
4-14	A6	Band Control Logic
	A7	Not Used
4-15	A8	YIG Driver 01.1 GHz-4 GHz
4-16, 4-17	A9	VTO/YIG Driver 4 GHz-8 GHz
4-18	A10	YIG Driver 8 GHz-12.4 GHz
4-19	A11	YIG Driver 12.4 GHz-18 GHz
4-20	A12	Voltage Regulator #2
4-21	A13	Voltage Regulator #1
4-22	A14	Power Supply
4-23	A15	Mother Board
4-24	A16	-5 V Regulator
4-25	A17	Switch Board
4-6		Main Assemblies and Chassis Parts
4-7		Option 10 Parts
4-8		Interconnect Parts

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TABLE 4-2. CODE LIST OF MANUFACTURERS

CODE NO.	MANUFACTURER	ADDRESS
0000A*	Krytar	Kansas City, Mo.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
02114	Ferroxcube Corp.	Saugerties, N.Y.
02660	Amphenol Bunker Ramo Corp., Connector Div.	Broadview, Ill.
04713	Motorola Inc.	Phoenix, Ariz.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
10133	Buss Machine Works, Inc.	Holland, Mich.
10389	Chicago Switch, Inc.	Chicago, Ill.
11139	Deutsch Co., Electronic Components Div.	Banning, Calif.
11312	Teledyne Mech.	Palo Alto, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Ariz.
13919	Burr-Brown Research Corp.	Tucson, Ariz.
14099	Semtech Corp.	Newbury Park, Calif.
14196	American Laboratories Div. of American Electronics Inc.	Fullerton, Calif.
14655	Cornell-Dubilier Electric	Newark, N.J.
17896	Schrack Cand Co.	Phoenixville, Penn.
18324	Signetics Corp.	Sunnyvale, Calif.
18489	Reliable Capacitors, Inc.	North Hollywood, Calif.
19701	Electra Mfg.	Independence, Kansas
26805	American Corp.	Waltham, Mass.
27264	Molex Products Co., Inc.	Downers Grove, Ill.
28480	Hewlett-Packard Co., Paeco Div.	Palo Alto, Calif.
29083	Monsanto Co., Inc.	Santa Clara, Calif.
31918	International Electronics Exchange	Minneapolis, Minn.
31951	Triridge Corp.	Aliquippa, Penn.
32293	Intersil, Inc.	Cupertino, Calif.
56289	Sprague Electric Co.	Springfield, Ill.
71590	Globe-Union, Inc., Centralab Div.	Milwaukee, Wis.
72136	Electro Motive Mfg, Co. Inc.	Willimantic, Conn.
72982	Erie Technological Products, Inc.	Erie, Penn.
73138	Beckman Instruments, Inc., Helipot Div.	Fullerton, Calif.
75042	IRC, Inc.	Philadelphia, Penn.

TABLE 4-2. CODE LIST OF MANUFACTURERS (CONT.)

CODE NO.	MANUFACTURER	ADDRESS
75915	Littelfuse, Inc.	Des Plaines, Ill.
84048	TRW Electronic Components Potentiometers Div.	St. Petersburg, Fla.
88245	Litton Industries, Useco Div.	Van Nuys, Calif.
88869	Singer Instrumentation	Los Angeles, Calif.
89110	AMP, Inc.	Elizabethtown, Penn.
90201	Mallory Capacitor Co.	Indianapolis, Ind.
91506	Augat, Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Neb.
91737	Gremar Mfg. Co.	Wakefield, Mass.
91836	Kings Electronics Co., Inc.	Tuckahoe, N.Y.
92703	Kemtron Electron Products, Inc.	Newburyport, Mass.
96067	Huggins Laboratories, Inc.	Sunnyvale, Calif.
97574	ITT Export Corp.	New York, N.Y.
98291	Sealectro Corp.	Mamaroneck, N.Y.
99313	Varian	Palo Alto, Calif.
IND-STD	Industry Standard Order from any Manufacturer	

*This vendor has no number assigned in the latest supplement to the Federal Supply Code for Manufacturers H4-2.

TABLE 4-3. REFERENCE SYMBOLS

AT	Attenuator, Isolator	OI	Optical Isolator
C	Capacitor	P	Plug, Connector
CR	Diode	Q	Transistor
CD	Directional Coupler	R	Resistor
DS	Lamp	S	Switch
J	Jack, Connector	T	Transformer
K	Relay	U	Integrated Circuit
L	Inductor	Z	Miscellaneous Parts: Ferrite Beads (RF Choke)

TABLE 4-4. ABBREVIATIONS

AF	Audio Frequency, 30 Hz - 30 kHz	mV	Millivolts
Cer.	Ceramic	mW	Milliwatts
Comp.	Composition	No.	Number
Dep. Car.	Deposited Carbon	NPNT	N Pole N Throw (N=Digit)(S=Single)
DM	Dipped Mica	Oper. Ampl.	Operational Amplifier
Elec.	Electrolytic, Aluminum	P/O	Part of
EHF	Extremely High Frequency, 30 - 300 GHz	Pot.	Potentiometer
F	Frequency	pF	Picofarad
Fact. Sel.	Factory Selected	RF	Radio Frequency
Freq. Mul.	Frequency Multiplier	Rect.	Rectifier
GMV	Guaranteed Minimum Value	SAF	Sub Audio Frequency, 0 - 30 Hz
GP	General Purpose	SHF	Super High Frequency, 3.0 - 30 GHz
HC	Hot Carrier (Diode)	Spec.	Special
HF	High Frequency, 3 - 20 MHz	Tant.	Tantalum, Electrolytic
IND-STD	Industry Standard	UHF	Ultra High Frequency, 300 - 3000 MHz (0.3 - 3.0 GHz)
k	Thousand		
LED	Light Emitting Diode	V	Volts
LF	Low Frequency, 30 - 300 kHz	Var.	Variable
m	0.001 (1/1000)	VHF	Very High Frequency, 30 - 300 MHz
M	Million	W	Watts
mA	Milliamperes	WW	Wirewound
MF	Metal Film	0 TC	Zero Temperature Coefficient
Med. Freq.	Medium Frequency, 300 - 3000 kHz	%	± % if sign not shown
Mfr.	Manufacturer	Ω	Ohms
		µF	Microfarads

TABLE 4-5. PARTS LIST FOR CONTROLLER ASSEMBLY

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
	952-879	BAND CONTROL	88869	
		CAPACITOR		
C1	12-82	0.47μF, ±20%, 100 V, fixed cer.	88245	CY30A474M
		RESISTORS		
R1		FACTORY SELECTED		
R2		FACTORY SELECTED		
R3		FACTORY SELECTED		
		INTEGRATED CIRCUITS		
U1	153-7031-001	Quad 2-Input	01295	SN5400N
U2	153-7031-001	Quad 2-Input	01295	SN5400N
U3	153-7055-001	Dual 4-Input	18324	S5420A
U4	153-7055-001	Dual 4-Input	18324	S5420A
U5	153-7055-001	Dual 4-Input	18324	S5420A
U6	153-7055-001	Dual 4-Input	18324	S5420A
U7	153-7031-001	Quad 2-Input	01295	SN5400N
U8	153-7031-001	Quad 2-Input	01295	SN5400N
U9	153-7031-001	Quad 2-Input	01295	SN5400N
U10	153-7031-001	Quad 2-Input	01295	SN5400N
U11	84-21	3 Terminal	07263	UGH7805393
	952-903	INNER PANEL	88869	
		DIODE		
CR1	81-276	Light Emitting	29083	MV10B
		RESISTOR		
R4	912-185	Dual Pot., 1 KΩ. ±10%, 0.5 W	88869	
	952-274-01	PUSH BUTTON ASSEMBLY	88869	
	952-880	TRANSITION	88869	
		CONNECTOR		
J1	168-2003-001	Receptical Cable - Chassis 50P	88869	
	942-407	DIAL FACE PLATES	88869	
		(See Table 4-26)		

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TABLE 4-6. PARTS LIST FOR MAIN ASSEMBLIES AND CHASSIS

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
A1	103-2311-001	Remote Level Function Assembly	88869	
A2	103-3113-001	FM Modulation Assembly	88869	
A3	103-2271-001	PM and Leveling 2 Assembly	88869	
A4	103-2275-001	Leveling 1 Assembly	88869	
A5	103-3118-005	Connector Assembly	88869	
A6	103-3124-001	Band Control Logic II Assembly	88869	
A7		NOT ASSIGNED		
A8	103-3115-001	YIG Driver (0.1 GHz-4 GHz) Assembly	88869	
A9	103-3117-003	VTO Driver (4 GHz-8 GHz) Assembly	88869	
A9	103-3114-003	YIG Driver (4 GHz-8 GHz) Assembly	88869	
A10	103-3110-003	YIG Driver (8 GHz-12.4 GHz) Assembly	88869	
A11	103-3109-003	YIG Driver (12.4 GHz-18 GHz) Assembly	88869	
A12	952916-01	Voltage Regulator No. 2 Assembly	88869	
A13	952915-01	Voltage Regulator No. 1 Assembly	88869	
A14	952918-01	Power Supply Assembly	88869	
A15	952924-01	Mother Board Assembly	88869	
A16	103-2202-001	-5 V Regulator Assembly	88869	
A17	103-2177-001	Switch Board Assembly	88869	
		RF COMPONENTS AND ACCESSORIES		
		ISOLATORS		
AT1	252-21	2-4 GHz	14196	ON 1012
AT2	252-24	8-12 GHz	11312	T8M43A1B
AT3	165-2000-001	4-8 GHz	14196	AMF4890
AT4	165-2000-002	12-18 GHz	11312	T12M43A1B
		CAPACITOR		
C1	12-82	0.47μF, ±20%, 100 V, fixed Cer.	88245	CY30A474M
		CONNECTORS		
CP1	168-4076-001	Adaptor, Plug to Plug	26805	2081-0000
CP2	168-4076-001	Adaptor, Plug to Plug	26805	2081-0000
		SWITCH		
S1	165-3000-001	SPDT Pin	96067	M871-8
		OSCILLATOR ASSEMBLIES		
HY2	103-2266-001	SAMPLER ASSEMBLY 2-18 GHz	88869	

TABLE 4-6. PARTS LIST FOR MAIN ASSEMBLIES AND CHASSIS (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		DIODE		
CR1	165-4000-001	Crystal Dectector .01-18 GHz	28480	8472A
		DIRECTIONAL COUPLER		
DC1	165-0000-002	2-18 GHz	0000A	1816T
Y1	103-2188-003	OSCILLATOR ASSEMBLY 2-4.2 GHz	88869	
		DIODE		
CR1	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
W1	102-9409-001	CABLE ASSEMBLY	88869	
Y1	113-016	YIG OSCILLATOR	88869	
Y2	103-2191-001	2-4 GHz	88869	
		OSCILLATOR ASSEMBLY 8-12 GHz		
		DIODE		
CR2	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
		OSCILLATOR		
Y2	113-026	Special X-Band	99313	VSX9072CA
Y3	103-2190-001	OSCILLATOR ASSEMBLY 4-8 GHz	88869	
		CAPACITOR		
C3	12-100	10μF, ±20%, 30 V, fixed Tant.	97574	TAG-10/35-20
		TUBE		
Y3	133-022	4-8 GHz BTO	88869	
Y4	103-2192-001	OSCILLATOR ASSEMBLY 12-18 GHz	88869	
		DIODE		
CR4	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
		TUBE		
Y4	113-025	Special Ku Band	99313	VSU 9077CE
		RF CABLES		
W2	102-9416-001	CABLE ASSEMBLY	88869	
		CONNECTORS		
J1	168-4077-001	SMA Cable Plug	11139	DC301D-75-008
J2	168-4077-001	SMA Cable Plug	11139	DC301D-75-008
W3	102-9478-001	CABLE ASSEMBLY SW-ISO	88869	
		CONNECTORS		
J1	168-7077-001	SMA Cable Plug	11139	DC301D-75-008
J2	168-7077-001	SMA Cable Plug	11139	DC301D-75-008
W4	102-9479-001	CABLE ASSEMBLY ISO-OSC	88869	

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TABLE 4-6. PARTS LIST FOR MAIN ASSEMBLIES AND CHASSIS (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CONNECTORS		
J1	168-4077-001	SMA Cable Plug	11139	DC301D-75-008
J2	168-4077-001	SMA Cable Plug	11139	DC301D-75-008
	102-9204-002	CABLE INTERFACE	88869	
		CONNECTORS		
P1	168-1015-001	Micro-Ribbon, 50 Contact	02660	57-30500
P2	168-1015-001	Micro-Ribbon, 50 Contact	02660	57-30500

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TABLE 4-7. PARTS LIST FOR OPTION 10 ASSEMBLY

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
	101-0477-111	9515B OPT. 10 PRE ASSEMBLY	88869	
		OSCILLATOR ASSEMBLIES		
Y2	103-2191-002	OSCILLATOR ASSEMBLY 8-12 GHz	88869	
		DIODE		
CR2	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
		YIG		
Y2	113-1005-001	8-12.4 GHz Hi Power		
Y4	103-2192-002	OSCILLATOR ASSEMBLY 12-18 GHz	88869	
		DIODE		
CR4	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
		YIG		
Y4	113-1006-001	12.4-18 GHz Hi Power	88869	

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TABLE 4-8. PARTS LIST FOR INTERCONNECTS

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CONTROL ASSEMBLIES ACCESSORIES		
	103-2183-001	BASIC ASSEMBLY 9515 60 GHz	88869	
	102-0202-001	CABLE ASSEMBLY PS/MOTH BD	88869	
		CONNECTORS		
	168-8084-001	15 Pin Plug	27264	09-50-3151
	103-2185-001	REAR PANEL ASSEMBLY	88869	
		CONNECTORS		
J3	131-33	BNC Female Chassis	91737	UG-1094A/U
J4	131-33	BNC Female Chassis	91737	UG-1094A/U
	103-3130-001	HARNESS ASSEMBLY	88869	
		CONNECTORS		
	168-1010-001	BNC Bulkhead Socket	91836	19-139
	168-4080-001	SMC Straight Plug	98291	50-007-0000
	556-147-021	BNC RG/188	98291	58-007-0000
		FRONT PANEL ASSEMBLY		
	103-2184-007	9515 B and Opt. 10	88869	
		Front Panel Assembly contains the following replaceable parts:		
		INDICATORS		
	126-26	Lamp, 28 V, .040 A	IND-STD	#388

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TABLE 4-9. PARTS LIST FOR REMOTE LEVELING FUNCTION ASSEMBLY, A1

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
C1	12-56	0.01μF, ±20%, 25 V, fixed cer.	56289	C069B250E103Z
C2	12-56	0.01μF, ±20%, 25 V, fixed cer.	56289	C069B250E103Z
		TRANSISTORS		
Q1	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q2	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q3	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q4	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q5	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q6	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q7	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q8	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q9	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q10	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors 1/4 W, ±1% metal film.		
R1	59-383	383Ω	19701	RN55-D-3830F
R2	59-383	383Ω	19701	RN55-D-3830F
R3	59-383	383Ω	19701	RN55-D-3830F
R4	59-383	383Ω	19701	RN55-D-3830F
R5	59-383	383Ω	19701	RN55-D-3830F
R6	59-383	383Ω	19701	RN55-D-3830F
R7	59-383	383Ω	19701	RN55-D-3830F
R8	59-2.37K	2.37 KΩ	19701	RN55-D-2371F
R9	59-2.37K	2.37 KΩ	19701	RN55-D-2371F
R10	59-2.37K	2.37 KΩ	19701	RN55-D-2371F
R11	59-2.37K	2.37 KΩ	19701	RN55-D-2371F
R12	59-2.37K	2.37 KΩ	19701	RN55-D-2371F
R13	59-2.37K	2.37 KΩ	19701	RN55-D-2371F
R14	59-2.37K	2.37 KΩ	19701	RN55-D-2371F
R15	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R16	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R17	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R18	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R19	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F

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TABLE 4-9. PARTS LIST FOR REMOTE LEVELING FUNCTION ASSEMBLY, A1 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R20	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R21	59-5.11K	5.11 KΩ	19701	RN55-D-5111F
R22	59-5.11K	5.11 KΩ	19701	RN55-D-5111F
R23	59-5.11K	5.11 KΩ	19701	RN55-D-5111F
R24	59-5.11K	5.11 KΩ	19701	RN55-D-5111F
R25	59-5.11K	5.11 KΩ	19701	RN55-D-5111F
R26	59-5.11K	5.11 KΩ	19701	RN55-D-5111F
R27	59-5.11K	5.11 KΩ	19701	RN55-D-5111F
R28	59-5.11K	5.11 KΩ	19701	RN55-D-5111F
R29	59-5.11K	5.11 KΩ	19701	RN55-D-5111F
R30	59-5.11K	5.11 KΩ	19701	RN55-D-5111F
R31	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R32	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R33	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R34	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R35	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R36	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R37	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R38	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R39	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R40	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R41	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R42	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R43	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
		INTEGRATED CIRCUITS		
U1	158-5001-001	Optical Isolator	29083	MCT-2
U2	158-5001-001	Optical Isolator	29083	MCT-2
U3	158-5001-001	Optical Isolator	29083	MCT-2
U4	158-5001-001	Optical Isolator	29083	MCT-2
U5	158-5001-001	Optical Isolator	29083	MCT-2
U6	158-5001-001	Optical Isolator	29083	MCT-2
U7	158-5001-001	Optical Isolator	29083	MCT-2
U8	153-7041-001	Quad 2 Input Nor Gate	18324	S5402A
U9	153-7041-001	Quad 2 Input Nor Gate	18324	S5402A
U10	153-7041-001	Quad 2 Inpui Nor Gate	18324	S5402A

TABLE 4-10. PARTS LIST FOR FM MODULATION ASSEMBLY, A2

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless othersie specified, all capacitors are fixed ceramic.		
C1	12-44	680 pf, ±10%, 1 KV	71590	DD-681
C2	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C3	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C4	12-27	270 pF, ±10%, 1 KV	71590	DD-271
C5	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C6	12-47	120 pF, ±10%, 1 KV	72982	831-X5R-121K
C7	12-18	200 pF, ±10%, 600 V	72982	831-X550-201K
C8	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C9	12-2	0.001μF, ±10%, 1 KV	72982	851-X5R-102K
C10	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C11	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C12	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C13	12-47	120 pF, ±10%, 1 KV	72982	831-X5R-121K
C14	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C15	12-27	270 pF, ±10%, 1 KV	71590	DD-271
C16	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C17	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C18	12-18	200 pF, ±10%, 600 V	72982	831-X550-201K
C19	12-100	10μF, ±20%, 35 V, Tant.	97574	TAG-10/35-20
C20	12-100	10μF, ±20%, 35 V, Tant.	97574	TAG-10/35-20
C21	12-100	10μF, ±20%, 35 V, Tant.	97574	TAG-10/35-20
C22	12-100	10μF, ±20%, 35 V, Tant.	97574	TAG-10/35-20
C23	12-44	680 pF, ±10%, 1 KV	71590	DD-681
C24	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
		DIODES		
CR1	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR2	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR3	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR4	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR5	81-311	Zener, 4.7 V, ±5%, 1 W	IND-STD	1N4732A
CR6	81-311	Zener, 4.7 V, ±5%, 1 W	IND-STD	1N4732A
CR7	81-311	Zener, 4.7 V, ±5%, 1 W	IND-STD	1N4732A
CR8	81-311	Zener, 4.7 V, ±5%, 1 W	IND-STD	1N4732A

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TABLE 4-10. PARTS LIST FOR FM MODULATION ASSEMBLY, A2 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		INDUCTORS		
L1	156-7005-002	750Ω , ±20%, 50 MHz	02114	VK200 10/3B
L2	156-7005-002	750Ω , ±20%, 50 MHz	02114	VK200 10/3B
L3	156-7005-002	750Ω , ±20%, 50 MHz	02114	VK200 10/3B
L4	156-7005-002	750Ω , ±20%, 50 MHz	02114	VK200 10/3B
L5	156-7005-002	750Ω , ±20%, 50 MHz	02114	VK200 10/3B
L6	156-7005-002	750Ω , ±20%, 50 MHz	02114	VK200 10/3B
L7	156-7005-002	750Ω , ±20%, 50 MHz	02114	VK200 10/3B
L8	156-7005-002	750Ω , ±20%, 50 MHz	02114	VK200 10/3B
		TRANSISTORS		
Q1	153-5005-001	G.P., 100 V, 10 W, B30-130	IND-STD	2N6178
Q2	153-5006-001	PNP, 100 V, 25 W, B30-130	IND-STD	2N6180
Q3	81-137	PNP, 60 VC Max, 0.3 W, B40-120	07263	2N3568
Q4	81-129	PNP, 60 VC Max, 0.3 W, B115-300	07263	2N3645
Q5	81-129	PNP, 60 VC Max, 0.3 W, B115-300	07263	2N3645
Q6	81-268	Dual NPN Silicon, 45 V, B80-min.	32293	IT 122E
Q7	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q8	81-268	Dual NPN Silicon, 45 V, B80-min.	32293	IT 122E
Q9	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q10	81-129	PNP, 60 VC Max, 0.3 W, B115-300	07263	2N3645
Q11	81-129	PNP, 60 VC Max, 0.3 W, B115-300	07263	2N3645
Q12	81-137	PNP, 60 VC Max, 0.3 W, B40-120	07263	2N3568
Q13	153-5005-001	G.P., 100 V, 10 W, B30-130	IND-STD	2N6178
Q14	153-5006-001	PNP, 100 V, 25 W, B30-130	IND-STD	2N6180
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/4 W, ±1% metal film.		
R1	59-249	249Ω	19701	RN55-D-2490F
R2	59-100	100Ω	19701	MF5C-D-1000F
R3	56-10.0	10.0Ω, 1/2 W	19701	MF6C-D-10R0F
R4	56-10.0	10.0Ω, 1/2 W	19701	MF6C-D-10R0F
R5	56-10.0	10.0Ω, 1/2 W	19701	MF6C-D-10R0F
R6	56-10.0	10.0Ω, 1/2 W	19701	MF6C-D-10R0F
R7	59-100	100Ω	19701	MF5C-D-1000F
R8	59-562	562Ω	19701	RN55-D-5620F
R9		NOT ASSIGNED		96

TABLE 4-10. PARTS LIST FOR FM MODULATION ASSEMBLY, A2 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R10	59-205	205 Ω	19701	RN55-D-2050F
R11	59-205	205 Ω	19701	RN55-D-2050F
R12	59-221	221 Ω	19701	RN55-D-2210F
R13	59-499	499 Ω	19701	MF5C-D-4990F
R14	59-7.50K	7.50 K Ω	19701	RN55-D-7501F
R15	59-1.00K	1.00 K Ω	19701	MF5C-D-1001F
R16	59-3.01K	3.01 K Ω	19701	RN55-D-3011F
R17	59-7.50K	7.50 K Ω	19701	RN55-D-7501F
R18	59-422	422 Ω	19701	MF5C-D-4220F
R19	59-604	604 Ω	19701	RN55-D-6040F
R20	59-3.40K	3.40 KΩ	19701	MF5C-D-3401F
R21	59-3.40K	3.40 KΩ	19701	MF5C-D-3401F
R22	59-604	604 Ω	19701	RN55-D-6040F
R23	59-7.50K	7.50 K Ω	19701	RN55-D-7501F
R24	59-1.00K	1.00 K Ω	19701	MF5C-D-1001F
R25	59-7.50K	7.50 K Ω	19701	RN55-D-7501F
R26	59-3.01K	3.01 K Ω	19701	RN55-D-3011F
R27	59-1.00K	1.00 K Ω	19701	MF5C-D-1001F
R28	59-422	422 Ω	19701	MF5C-D-4220F
R29	59-499	499 Ω	19701	MF5C-D-4990F
R30	59-221	221 Ω	19701	RN55-D-2210F
R31	59-205	205 Ω	19701	RN55-D-2050F
R32	59-205	205 Ω	19701	RN55-D-2050F
R33		NOT ASSIGNED		
R34	59-562	562 Ω	19701	RN55-D-5620F
R35	59-100	100 Ω	19701	MF5C-D-1000F
R36	59-100	100 Ω	19701	MF5C-D-1000F
R37	56-10.0	10.0 Ω, 1/2 W	19701	MF6C-D-10R0F

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TABLE 4-10. PARTS LIST FOR FM MODULATION ASSEMBLY, A2 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R38	56-10.0	10.0Ω, 1/2 W	19701	MF6C-D-10R0F
R39	56-10.0	10.0Ω, 1/2 W	19701	MF6C-D-10R0F
R40	56-10.0	10.0Ω, 1/2 W	19701	MF6C-D-10R0F
R41	56-10.0	10.0Ω, 1/2 W	19701	MF6C-D-10R0F
R42	56-10.0	10.0Ω. 1/2 W	19701	MF6C-D-10R0F
R43	56-10.0	10.0Ω, 1/2 W	19701	MF6C-D-10R0F
R44	56-10.0	10.0Ω, 1/2 W	19701	MF6C-D-10R0F
R45	59-249	249Ω	19701	RN55-D-2490F
R46	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F

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TABLE 4-11. PARTS LIST FOR PM AND LEVELING 2 ASSEMBLY, A3

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless otherwise specified, all capacitors are fixed ceramic.		
C1	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C2	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C3	150-2002-201FG0	200 pF, ±20%, 500 V, fixed DM	14655	CMD5FD201G03
C4	150-2002-200EG0	20 pF, ±20%, 500 V, fixed DM	14655	CD15CD200G03
C5	12-47	120 pF, ±10%, 1 KV	72982	831-X5R-121K
C6	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C7	12-27	270 pF, ±10%, 1 KV	71590	DD-271
C8	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C9	12-42	39 pF, ±10%, 100 V	71590	DD-390
C10	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C11	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C12	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C13	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C14	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C15	12-21	27 pF, ±5%, 1 KV	72982	831-U2M-270K
C16	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C17	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C18	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C19	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C20	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C21	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C22	13-89	100μF, ±20%, 20 V, fixed Tant.	56289	196D107X0020MA3
C23	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C24		NOT ASSIGNED		
C25		NOT ASSIGNED		
C26	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C27	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
		DIODES		
CR1	154-4001-001	Hot Carrier, 250 mW, 70 V	28480	HP5082-2800
CR2	154-4001-001	Hot Carrier, 250 mW, 70 V	28480	HP5082-2800
CR3	154-4001-001	Hot Carrier, 250 mW, 70 V	28480	HP5082-2800
CR4	154-4001-001	Hot Carrier, 250 mW, 70 V	28480	HP5082-2800
CR5	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148

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TABLE 4-11. PARTS LIST FOR PM AND LEVELING 2 ASSEMBLY, A3 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
CR6	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR7	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR8	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR9	154-4004-001	Hot Carrier, 100 psec	28480	HP5082-2835
CR10	154-4004-001	Hot Carrier, 100 psec	28480	HP5082-2835
CR11	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR12	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR13	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR14	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR15	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR16		NOT ASSIGNED		
CR17	154-0020-001	Zener, 3.9 V, ±5%, 1 W	IND-STD	1N4730A
CR18	81-311	Zener, 4.7 V, ±5%, 1 W	IND-STD	1N4732A
CR19	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
		INDUCTORS		
L1	156-7005-002	750Ω, ±20%, 50 MHz	02114	VK200 10/3B
L2	156-7005-002	750Ω, ±20%, 50 MHz	02114	VK200 10/3B
		TRANSISTORS		
Q1	81-116	PNP, 15 VC Max, 0.2 W, B30-120	IND-STD	2N3646
Q2	81-116	PNP, 15 VC Max, 0.2 W, B30-120	IND-STD	2N3646
Q3	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q4	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q5	81-116	PNP, 15 VC Max, 0.2 W, B30-120	IND-STD	2N3646
Q6	81-116	PNP, 15 VC Max, 0.2 W, B30-120	IND-STD	2N3646
Q7	81-116	PNP, 15 VC Max, 0.2 W, B30-120	IND-STD	2N3646
Q8	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q9	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q10		NOT ASSIGNED		
Q11	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q12	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q13	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q14	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q15	81-137	PNP, 60 VC Max, 0.3 W, B40-120	07263	2N3568
Q16	153-5005-001	G.P., 10 W, 100 V, B30-130	IND-STD	2N6178
Q17	153-5005-001	G.P., 10 W, 100 V, B30-130	IND-STD	2N6178
Q18		NOT ASSIGNED		

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TABLE 4-11. PARTS LIST FOR PM AND LEVELING 2 ASSEMBLY, A3 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
Q19	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q20	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q21	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q22	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q23	81-129	PNP, 60 VC Max, 0.3 W, B115-300	07263	2N3645
Q24	153-5006-001	PNP, 100 VC Max, 25 W, B30-130	IND-STD	2N6180
Q25	153-5005-001	G.P., 10 W, 100 V, B30-130	IND-STD	2N6178
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/4 W, ±1% metal film.		
R1	59-110	110 Ω	19701	RN55-D-1100F
R2	59-110	110 Ω	19701	RN55-D-1100F
R3	59-3.16K	3.16 K Ω	19701	RN55-D-3161F
R4	59-6.04	6.04 K Ω	19701	RN55-D-6041F
R5	59-9.76K	9.76 K Ω	19701	RN55-D-9761F
R6	59-301	301 Ω	19701	RN55-D-3010F
R7	59-3.48K	3.48 K Ω	19701	RN55-D-3481F
R8	59-1.00K	1.00 K Ω	19701	MF5C-D-1001F
R9	59-3.48K	3.48 K Ω	19701	RN55-D-3481F
R10	59-523	523 Ω	19701	MF5C-D-5230F
R11	59-1.33K	1.33 K Ω	19701	RN55-D-1331F
R12	59-4.64K	4.64 K Ω	19701	MF5C-D-4641F
R13	59-464	464 Ω	19701	RN55-D-4640F
R14	59-249	249 Ω	19701	RN55-D-2490F
R15	59-3.01K	3.01 K Ω	19701	RN55-D-3011F
R16	59-3.01K	3.01 K Ω	19701	RN55-D-3011F
R17	56-249	249 Ω, 1/2 W	19701	MF6C-D-2490F
R18	56-249	249 Ω, 1/2 W	19701	MF6C-D-2490F
R19	56-249	249 Ω, 1/2 W	19701	MF6C-D-2490F
R20	56-1.21K	1.21 K Ω, 1/2 W	19701	MF6C-D-1211F
R21		NOT ASSIGNED		
R22	56-80.6	80.6 Ω, 1/2 W	19701	RN60-D-80R6F
R23	56-80.6	80.6 Ω, 1/2 W	19701	RN60-D-80R6F
R24	59-4.64K	4.64 K Ω	19701	MF5C-D-4641F
R25	59-4.64K	4.64 K Ω	19701	MF5C-D-4641F
R26	59-4.64K	4.64 K Ω	19701	MF5C-D-4641F

TABLE 4-11. PARTS LIST FOR PM AND LEVELING 2 ASSEMBLY, A3 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R27	59-4.64K	4.64 K Ω	19701	MF5C-D-4641F
R28		NOT ASSIGNED		
R29		NOT ASSIGNED		
R30		NOT ASSIGNED		
R31	59-4.64K	4.64 K Ω	19701	MF5C-D-4641F
R32	59-4.64K	4.64 K Ω	19701	MF5C-D-4641F
R33	59-100K	100 K Ω	19701	MF5C-D-1003F
R34		NOT ASSIGNED		
R35	59-4.64K	4.64 K Ω	19701	MF5C-D-4641F
R36	59-100K	100 K Ω	19701	MF5C-D-1003F
R37	59-4.64K	4.64 K Ω	19701	MF5C-D-4641F
R38	59-4.64K	4.64 K Ω	19701	MF5C-D-4641F
R39	59-4.64K	4.64 K Ω	19701	MF5C-D-4641F
R40	59-10.0K	10.0 K Ω	19701	RN55-D-1002F
R41	59-4.99K	4.99 K Ω	19701	MF5C-D-4991F
R42	59-27.4K	27.4 K Ω	19701	MF5C-D-2742F
R43	59-3.16K	3.16 K Ω	19701	RN55-D-3161F
R44	59-499	499Ω	19701	MF5C-D-4990F
R45	59-10.0K	10.0 K Ω	19701	RN55-D-1002F
R46		NOT ASSIGNED		
R47	59-182	182 Ω	19701	RN55-D-1820F
R48		NOT ASSIGNED		
R49	56-221	221 Ω, 1/2 W	19701	MF6C-D-2210F
R50	56-221	221 Ω, 1/2 W	19701	MF6C-D-2210F
R51	56-221	221 Ω, 1/2 W	19701	MF6C-D-2210F
R52	59-10.0K	10.0 K Ω	19701	RN55-D-1002F
R53	59-499	499Ω	19701	MF5C-D-4990F
R54	59-10.0K	10.0 K Ω	19701	RN55-D-1002F
R55	59-1.00K	1.00 K Ω	19701	MF5C-D-1001F
R56	59-15.4K	15.4 K Ω	19701	RN55-D-1542F
R57	59-6.65K	6.65 K Ω	19701	RN55-D-6651F

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TABLE 4-11. PARTS LIST FOR PM AND LEVELING 2 ASSEMBLY, A3 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R58	59-20.0K	20.0 KΩ	19701	RN55-D-2002F
R59	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R60	59-100	100Ω	19701	MF5C-D-1000F
R61	59-100	100Ω	19701	MF5C-D-1000F
R62	59-196	196Ω	19701	RN55-D-1960F
R63	59-499	499Ω	19701	MF5C-D-4990F
R64	59-392	392Ω	19701	MF5C-D-3920F
R65	59-196	196Ω	19701	RN55-D-1960F
R66	59-3.48K	3.48 KΩ	19701	RN55-D-3481F
R67	59-1.50K	1.50 KΩ	19701	MF5C-D-1501F
R68	59-196	196Ω	19701	RN55-D-1960F
R69	59-24.9	24.9Ω	19701	RN55-D-24R9F
R70	59-24.9	24.9Ω	19701	RN55-D-24R9F
R71	59-66.5	66.5Ω	19701	RN55-D-66R5F
R72	59-464	464Ω	19701	RN55-D-4640F
R73	59-392	392Ω	19701	MF5C-D-3920F
		SWITCHES		
S1	161-0040-001	Slide, DPDT Mount	10389	23-021-114
S2	161-0040-001	Slide, DPDT Mount	10389	23-021-114
		INTEGRATED CIRCUITS		
U1	153-7041-001	Quad 2 Input Nor Gate	18324	S5402A
U2	153-7031-001	Quad 2 Input Nand Gate	01295	SN5400N
U3	84-1	Op. Amp.	18324	LM101A
U4	84-1	Op, Amp.	18324	LM101A

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TABLE 4-12. PARTS LIST FOR LEVELING 1 ASSEMBLY, A4

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless otherwise specified, all capacitors are fixed ceramic.		
C1		NOT ASSIGNED		
C2		NOT ASSIGNED		
C3	12-42	39 pF, ±10%, 100 V	71590	DD-390
C4	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C5	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C6	150-2002-131FG0	130 pF, ±2%, 500 V, fixed DM	72136	DM15F131G0500
C7	12-21	27 pF, ±5%, 1 KV	72982	831-U2M-270K
C8	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C9	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C10	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C11	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C12	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C13	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C14	12-21	27 pF, ±5%, 1 KV	72982	831-U2M-270K
C15	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C16	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C17	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C18	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C19	12-56	0.01μF. ±20%, 25 V	56289	C069B250E103Z
C20	12-56	0.01μF. ±20%, 25 V	56289	C069B250E103Z
C21	12-21	27 pF, ±5%, 1 KV	72982	831-U2M-270K
C22	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C23	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C24	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C25	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C26	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C27	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C28	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C29	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C30	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C31	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C32	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C33	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20

TABLE 4-12. PARTS LIST FOR LEVELING 1 ASSEMBLY, A4 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
C34	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C35	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C36	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
		DIODES		
CR1		NOT ASSIGNED		
CR2	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR3	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR4	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR5		NOT ASSIGNED		
CR6	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR7	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR8	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR9	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR10	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR11	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
		RELAY		
K1	106-61	24 V, SPDT	31951	220-001-24
		INDUCTORS		
L1	156-7005-002	750Ω, ±20%, 50 MHz	02114	VK200 10/3B
L2	156-7005-002	750Ω, ±20%, 50 MHz	02114	VK200 10/3B
		TRANSISTORS		
Q1		NOT ASSIGNED		
Q2	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q3	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q4	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q5	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q6		NOT ASSIGNED		
Q7		NOT ASSIGNED		
Q8	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q9	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q10	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q11	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q12	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q13	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q14	153-5005-001	G.P., 100 V, 10 W, B30-130	IND-STD	2N6178
Q15	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904

TABLE 4-12. PARTS LIST FOR LEVELING 1 ASSEMBLY, A4 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
Q16	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q17	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q18	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q19	81-129	PNP, 60 VC Max, 0.3 W., B115-300	07263	2N3645
Q20	153-5006-001	PNP, 100 V, 25 W, B30-130	IND-STD	2N6180
Q21	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q22	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q23	153-5005-001	G.P., 100 V, 10 W, B30-130	IND-STD	2N6178
Q24	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q25	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q26	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q27	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q28	81-129	PNP, 60 VC Max, 0.30 W, B115-300	07263	2N3645
Q29	153-5006-001	PNP, 100 V., 25 W, B30-130	IND-STD	2N6180
Q30	153-4003-001	FET Switching, 350 mW, 6.0V	17896	E-175
Q31	556-146-989	NPN, 40 V Max, 0.31 W, B100-300	IND-STD	2N3904
Q32	153-5005-001	G.P., 100 V, 10 W, B30-130	IND-STD	2N6178
Q33	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q34	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q35	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q36	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q37	81-129	PNP, 60 VC Max, 0.30 W, B115-300	07263	2N3645
Q38	153-5006-001	PNP, 100 V, 25 V, B30-130	IND-STD	2N6180
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/4 W, ±1% metal film		
R1		NOT ASSIGNED		
R2		NOT ASSIGNED		
R3		NOT ASSIGNED		
R4		NOT ASSIGNED		
R5	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R6	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R7	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R8	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R9	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R10	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F

TABLE 4-12. PARTS LIST FOR LEVELING 1 ASSEMBLY, A4 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R11	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R12	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R13	59-100K	100 KΩ	19701	MF5C-D-1003F
R14	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R15	59-976K	976 KΩ	19701	RN60-D-9763F
R16	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R17	71-129	Pot., 100 KΩ, ±10%, 3/4W	75042	960-290-100K
R18	59-49.9K	49.9 KΩ	19701	MF5C-D-4992F
R19	59-249K	249 KΩ	19701	MF5C-D-2493F
R20	71-91	Pot., 500Ω, ±10%, 3/4W	75042	960-290-500Ω
R21	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R22	59-1.00K	1.00 KΩ	19701	RN55-D-1001F
R23	59-249	249Ω	19701	RN55-D-2490F
R24	59-100K	100 KΩ	19701	MF5C-D-1003F
R25	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R26	59-499	499Ω	19701	MF5C-D-4990F
R27	59-7.15K	7.15 KΩ	19701	RN55-D-7151F
R28	59-8.25K	8.25 KΩ	19701	MF5C-D-8251F
R29	59-1.00K	1.00 KΩ	19701	RN55-D-1001F
R30	59-20.0K	20.0 KΩ	19701	MF5C-D-2002F
R31	71-105	Pot., 1.00 KΩ, ±10%, 3/4W	75042	960-620-1K
R32	59-750	750Ω	19701	RN55-D-7500F
R33	59-59.0K	59.0 KΩ	19701	RN55-D-5902F
R34		NOT ASSIGNED		
R35		NOT ASSIGNED		
R36	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R37	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R38	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R39		NOT ASSIGNED		
R40		NOT ASSIGNED		
R41		NOT ASSIGNED		
R42		NOT ASSIGNED		
R43	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R44	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R45	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R46	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R47	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F

TABLE 4-12. PARTS LIST FOR LEVELING 1 ASSEMBLY, A4 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R48	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R49	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R50	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R51	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R52	59-100K	100 KΩ	19701	MF5C-D-1003F
R53	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R54	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R55	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R56	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R57	59-15.4K	15.4 KΩ	19701	RN55-D-1542F
R58	59-6.65K	6.65 KΩ	19701	RN55-D-6651F
R59	59-499	499Ω	19701	MF5C-D-4990F
R60	59-20.0K	20.0 KΩ	19701	MF5C-D-2002F
R61	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R62	59-100	100Ω	19701	MF5C-D-1000F
R63	59-100	100Ω	19701	MF5C-D-1000F
R64	59-392	392Ω	19701	MF5C-D-3920F
R65	59-196	196Ω	19701	RN55-D-1960F
R66	59-3.48K	3.48 KΩ	19701	MF5C-D-3481F
R67	57-1.50K	1.50 KΩ	19701	MF5C-D-1501F
R68	59-196	196Ω	19701	RN55-D-1960F
R69	59-24.9	24.9Ω	19701	RN55-D-24R9F
R70	59-24.9	24.9Ω	19701	RN55-D-24R9F
R71	59-66.5	66.5Ω	19701	RN55-D-66R5F
R72	59-464	464Ω	19701	RN55-D-4640F
R73	59-392	392Ω	19701	MF5C-D-3920F
R74	59-196	196Ω	19701	RN55-D-1960F
R75	59-100K	100 KΩ	19701	MF5C-D-1003F
R76	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R77	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R78	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R79	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R80	59-15.4K	15.4 KΩ	19701	RN55-D-1542F
R81	59-6.65K	6.65 KΩ	19701	RN55-D-6651F
R82	59-499	499Ω	19701	MF5C-D-4990F
R83	59-20.0K	20.0 KΩ	19701	MF5C-D-2002F

TABLE 4-12. PARTS LIST FOR LEVELING 1 ASSEMBLY, A4 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R84	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R85	59-100	100Ω	19701	MF5C-D-1000F
R86	59-100	100Ω	19701	MF5C-D-1000F
R87	59-392	392Ω	19701	MF5C-D-3920F
R88	59-196	196Ω	19701	RN55-D-1960F
R89	59-3.48K	3.48 KΩ	19701	MF5C-D-3481F
R90	59-1.50K	1.50 KΩ	19701	MF5C-D-1501F
R91	59-196	196Ω	19701	RN55-D-1960F
R92	59-24.9	24.9Ω	19701	RN55-D-24R9F
R93	59-24.9	24.9Ω	19701	RN55-D-24R9F
R94	59-66.5	66.5Ω	19701	RN55-D-66R5F
R95	59-464	464Ω	19701	RN55-D-4640F
R96	59-392	392Ω	19701	MF5C-D-3920F
R97	59-196	196Ω	19701	RN55-D-1960F
R98	59-100K	100 KΩ	19701	MF5C-D-1003F
R99	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R100	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R101	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R102	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R103	59-15.4K	15.4KΩ	19701	RN55-D-1542F
R104	59-6.65K	6.65 KΩ	19701	RN55-D-6651F
R105	59-499	499Ω	19701	MF5C-D-4990F
R106	59-20.0K	20.0 KΩ	19701	MF5C-D-2002F
R107	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R108	59-100	100Ω	19701	MF5C-D-1000F
R109	59-100	100Ω	19701	MF5C-D-1000F
R110	59-392	392Ω	19701	MF5C-D-3920F
R111	59-196	196Ω	19701	RN55-D-1960F
R112	59-3.48K	3.48 KΩ	19701	MF5C-D-3481F
R113	59-1.50K	1.50 KΩ	19701	MF5C-D-1501F
R114	59-196	196Ω	19701	RN55-D-1960F
R115	59-24.9	24.9Ω	19701	RN55-D-24R9F
R116	59-24.9	24.9Ω	19701	RN55-D-24R9F

TABLE 4-12. PARTS LIST FOR LEVELING 1 ASSEMBLY, A4 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R117	59-66.5	66.5Ω	19701	RN55-D-66R5F
R118	59-464	464Ω	19701	RN55-D-4640F
R119	59-392	392Ω	19701	MF5C-D-3920F
R120	59-196	196Ω	19701	RN55-D-1960F
		INTEGRATED CIRCUITS		
U1		NOT ASSIGNED		
U2		NOT ASSIGNED		
U3	84-1	Op. Amp.	18324	LM101A
U4	84-1	Op. Amp.	18324	LM101A
U5	84-1	Op. Amp.	18324	LM101A
U6	84-1	Op. Amp.	18324	LM101A
U7	153-7055-001	Dual 4-Input	18324	S5420A
U8	153-7041-001	Quad 2-Input Nor Gate	18324	S5402A
		MISCELLANEOUS		
Z1	97-5	Ferrite Bead	02114	56-590-65/4B
Z2	97-5	Ferrite Bead	02114	56-590-65/4B
Z3	97-5	Ferrite Bead	02114	56-590-65/4B

Table 4-13. PARTS LIST FOR CONNECTOR ASSEMBLY, A5

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless otherwise specified, all capacitors are fixed ceramic.		
C1		NOT ASSIGNED		
C2		NOT ASSIGNED		
C3	12-14	0.0012μF, ±10%, 1 KV	56289	10TS-D12
C4	12-42	39 pF, ±10%, 1 KV	71590	DD-390
C5	12-15	0.002μF, GVM, 1 KV	71590	DD-202
C6	12-42	39 pF, ±10%, 1 KV	71590	DD-390
C7	12-100	10μF, ±25%, 35 V, fixed Tant.	97574	TAG-10/35-20
C8	12-100	10μF, ±25%, 35 V, fixed Tant.	97574	TAG-10/35-20
C9	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C10	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C11		NOT ASSIGNED		
C12	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C13	12-82	0.47μF, ±20%, 100V	88245	CY30A474M
		DIODES		
CR1		NOT ASSIGNED		
CR2		NOT ASSIGNED		
CR3	154-0013-001	G.P., 10mA, 75 V	IND-STD	IN4148
CR4	154-0013-001	G.P., 10mA, 75 V	IND-STD	IN4148
CR5	154-0013-001	G.P., 10mA, 75 V	IND-STD	IN4148
CR6	154-0013-001	G.P., 10mA, 75 V	IND-STD	IN4148
CR7	154-0013-001	G.P., 10mA, 75 V	IND-STD	IN4148
CR8	154-0013-001	G.P., 10mA, 75 V	IND-STD	IN4148
CR9	154-0013-001	G.P., 10mA, 75 V	IND-STD	IN4148
CR10	154-0013-001	G.P., 10mA, 75 V	IND-STD	IN4148
CR11		NOT ASSIGNED		
CR12		NOT ASSIGNED		
CR13	81-175	Zener, 30 V, ±5%, 1.0 W	IND-STD	IN4751A
CR14		NOT ASSIGNED		
CR15		NOT ASSIGNED		
CR16	81-190	G.P., 200mA, 80 V	IND-STD	IN270
CR17	81-190	G.P., 200mA, 80 V	IND-STD	IN270

TABLE 4-13. PARTS LIST FOR CONNECTOR ASSEMBLY, A5 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		TRANSISTORS		
Q1		NOT ASSIGNED		
Q2		NOT ASSIGNED		
Q3	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q4	153-4003-001	FET Swtiching, 350 mW, 6.0 V	17896	E-175
Q5	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q6	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q7		NOT ASSIGNED		
Q8		NOT ASSIGNED		
Q9	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q10	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q11	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q12	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q13	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q14	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q15	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q16	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q17		NOT ASSIGNED		
Q18		NOT ASSIGNED		
Q19	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/4 W, ±1% metal film.		
R1	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R2	31-21.0K	21.0 KΩ, ±0.1%	19701	RN55-D-2102B
R3	31-21.0K	21.0 KΩ, ±0.1%	19701	RN55-D-2102B
R4	59-210K	210 KΩ	19701	RN55-D-2103F
R5	31-21.0K	2.10 KΩ, ±0.1%	19701	RN55-D-2102B
R6	59-210K	210 KΩ	19701	RN55-D-2103F
R7	31-21.0K	21.0 KΩ, ±0.1%	19701	RN55-D-2102F
R8	59-9.53K	9.53 KΩ	19701	RN55-D-9531F
R9	59-9.53K	9.53 KΩ	19701	RN55-D-9531F
R10		NOT ASSIGNED		
R11		NOT ASSIGNED		
R12		NOT ASSIGNED		
R13		NOT ASSIGNED		

TABLE 4-13. PARTS LIST FOR CONNECTOR ASSEMBLY, A5 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R14	59-499K	499 KΩ	19701	MF5C-D-4993K
R15	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R16	59-499K	499 KΩ	19701	MF5C-D-4993F
R17	59-40.2K	40.2 KΩ	19701	MF5C-D-4022F
R18	59-60.4K	60.4 KΩ	19701	MF5C-D-6042F
R19	59-143K	143 KΩ	19701	RN55-D-1433F
R20	59-499K	499 KΩ	19701	RN55-D-4993F
R21	59-93.1K	93.1 KΩ	19701	RN55-D-9312F
R22		NOT ASSIGNED		
R23		NOT ASSIGNED		
R24		NOT ASSIGNED		
R25		NOT ASSIGNED		
R26		NOT ASSIGNED		
R27		NOT ASSIGNED		
R28	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R29	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R30	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R31	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R32	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R33	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R34	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R35	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R36		NOT ASSIGNED		
R37		NOT ASSIGNED		
R38	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R39	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R40	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R41	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R42		NOT ASSIGNED		
R43		NOT ASSIGNED		
R44	59-40.2K	40.2 KΩ	19701	MF5C-D-4022F
R45	59-40.2K	40.2 KΩ	19701	MF5C-D-4022F
R46	59-22.1K	22.1 KΩ	19701	RN55-D-2212F
R47	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R48	59-20.0K	20.0 KΩ	19701	MF5C-D-2002F

TABLE 4-13. PARTS LIST FOR CONNECTOR ASSEMBLY, A5 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R49	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R50	59-20.0K	20.0 KΩ	19701	MF5C-D-2002F
R51	56-4.99K	4.99 KΩ, 1/2 W	19701	MF6C-D-4991F
R52	59-80.6K	80.6 KΩ	19701	MF5C-D-8062F
R53	59-200K	200 KΩ	19701	MF5C-D-2003F
R54	59-12.4K	12.4 KΩ	19701	RN55-D-1242F
R55	59-86.6K	86.6 KΩ	19701	RN55-D-8662F
R56	59-200K	200 KΩ	19701	RN55-D-2003F
R57		NOT ASSIGNED		
R58		NOT ASSIGNED		
R59	59-845K	845 KΩ	19701	RN55-D-8453F
R60	59-499K	499 KΩ	19701	MF5C-D-4993F
R61	59-499K	499 KΩ	19701	MF5C-D-4993F
R62	59-499K	499 KΩ	19701	MF5C-D-4993F
R63	59-499K	499 KΩ	19701	MF5C-D-4993F
R64		NOT ASSIGNED		
R65		NOT ASSIGNED		
R66	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R67	59-21.0K	21.0 KΩ	19701	RN55-D-2102F
R68		NOT ASSIGNED		
R69		NOT ASSIGNED		
R70		NOT ASSIGNED		
R71		NOT ASSIGNED		
R72		NOT ASSIGNED		
R73		NOT ASSIGNED		
R74		NOT ASSIGNED		
R75		NOT ASSIGNED		
R76		NOT ASSIGNED		
R77		NOT ASSIGNED		
R78		NOT ASSIGNED		
R79		NOT ASSIGNED		
R80		NOT ASSIGNED		
R81		NOT ASSIGNED		
R82		NOT ASSIGNED		
R83		NOT ASSIGNED		

TABLE 4-13. PARTS LIST FOR CONNECTOR ASSEMBLY, A5 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R84		NOT ASSIGNED		
R85		NOT ASSIGNED		
R86		NOT ASSIGNED		
R87		NOT ASSIGNED		
R88		NOT ASSIGNED		
R89		NOT ASSIGNED		
R90		NOT ASSIGNED		
R91		NOT ASSIGNED		
R92		NOT ASSIGNED		
R93		NOT ASSIGNED		
R94		NOT ASSIGNED		
R95		NOT ASSIGNED		
R96	59-976K	976 KΩ	19701	RN60-D-9763F
		SWITCH		
S1	161-0040-001	Slide, DPDT	10389	23-021-114
		INTEGRATED CIRCUITS		
U1	153-7056-001	Op. Amp.	13919	3500A
U2	153-7056-001	Op. Amp.	13919	3500A
U3	84-1	Op. Amp.	18324	LM101A
U4	84-1	Op. Amp.	18324	LM101A
U5	153-7056-001	Op. Amp.	13919	3500A
U6	153-7044-001	Multivibrator	01295	SN54121N

TABLE 4-14. PARTS LIST FOR BAND CONTROL LOGIC II ASSEMBLY, A6

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless otherwise specified, all capacitors are fixed ceramic.		
C1	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C2	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C3	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C4	13-91	33μF, ±20%, 25 V, fixed Tant.	56289	196D336X0025LA3
C5	12-82	0.47μF, ±20%, 100V	88245	CY30A474M
C6	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C7	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C8	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C9	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
		DIODES		
CR1		NOT ASSIGNED		
CR2		NOT ASSIGNED		
CR3	154-0013-001	G.P., 10 mA, 75 V	IND-STD	IN4148
CR4	154-0013-001	G.P., 10 mA, 75 V	IND-STD	IN4148
CR5	154-0013-001	G.P., 10 mA, 75 V	IND-STD	IN4148
CR6	154-0013-001	G,P., 10 mA, 75 V	IND-STD	IN4148
CR7	154-0013-001	G.P., 10 mA, 75 V	IND-STD	IN4148
CR8	154-0013-001	G.P., 10 mA, 75 V	IND-STD	IN4148
CR9	154-0013-001	G.P., 10 mA, 75 V	IND-STD	IN4148
CR10	154-0013-001	G.P., 10 mA, 75 V	IND-STD	IN4148
CR11	154-0013-001	G.P., 10 mA, 75 V	IND-STD	IN4148
CR12	154-0013-001	G.P., 10 mA, 75 V	IND-STD	IN4148
CR13	154-0013-001	G.P., 10 mA, 75 V	IND-STD	IN4148
CR14	154-0013-001	G.P., 10 mA, 75 V	IND-STD	IN4148
CR15		NOT ASSIGNED		
CR16		NOT ASSIGNED		
CR17		NOT ASSIGNED		
CR18		NOT ASSIGNED		
CR19	154-0013-001	G.P., 10 mA, 75 V	IND-STD	IN4148
CR20	154-0013-001	G.P., 10 mA, 75 V	IND-STD	IN4148
CR21	154-0013-001	G.P., 10 mA, 75 V	IND-STD	IN4148
		CONNECTOR		
J1	133-128	P.C. Socket	91506	516-AG1D

TABLE 4-14. PARTS LIST FOR BAND CONTROL LOGIC II ASSEMBLY, A6 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		INDUCTORS		
L1	156-7005-002	750Ω, ±20%, 50 MHz	02114	VK20010/3B
L2	156-7005-002	750Ω, ±20%, 50 MHz	02114	VK20010/3B
L3	156-7005-002	750Ω, ±20%, 50 MHz	02114	VK20010/3B
L4	156-7005-002	750Ω, ±20%, 50 MHz	02114	VK20010/3B
L5	156-7005-002	750Ω, ±20%, 50 MHz	02114	VK20010/3B
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/4 W, 1% metal film.		
R1		NOT ASSIGNED		
R2		NOT ASSIGNED		
R3		NOT ASSIGNED		
R4		NOT ASSIGNED		
R5		NOT ASSIGNED		
R6		NOT ASSIGNED		
R7		NOT ASSIGNED		
R8		NOT ASSIGNED		
R9	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R10	59-7.50K	7.50 KΩ	19701	RN55-D-7501F
R11	59-7.15K	7.15 KΩ	19701	RN55-D-7151F
R12	71-90	Pot., 200Ω, ±10%, 3/4 W	75042	960-290-200Ω
R13	59-3.16K	3.16 KΩ	19701	MF5C-D-3161F
R14	59-100	100Ω	19701	MF5C-D-1000F
R15	59-13.3K	13.3 KΩ	19701	RN55-D-1332F
R16	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R17	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R18	59-7.50K	7.50 KΩ	19701	RN55-D-7501F
R19	59-5.36K	5.36 KΩ	19701	MF5C-D-5361F
R20	71-90	Pot., 200Ω, ±10%, 3/4 W	75042	960-290-200Ω
R21	59-4.75K	4.75 KΩ	19701	MF5C-D-4751F
R22	59-100	100Ω	19701	MF5C-D-1000F
R23	59-6.65K	6.65 KΩ	19701	RN55-D-6651F
R24	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R25	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R26	59-7.50K	7.50 KΩ	19701	RN55-D-7501F

TABLE 4-14. PARTS LIST FOR BAND CONTROL LOGIC II ASSEMBLY, A6 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R27	59-6.04K	6.04 KΩ	19701	RN55-D-6041F
R28	71-90	Pot., 200Ω, ±10%, 3/4 W	75042	960-290-200Ω
R29	59-4.22K	4.22 KΩ	19701	MF5C-D-4221F
R30	59-100	100Ω	19701	MF5C-D-1000F
R31	59-8.25K	8.25 KΩ	19701	RN55-D-8251K
R32	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R33	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R34	59-7.50K	7.50 KΩ	19701	RN55-D-7501F
R35	59-9.09K	9.09 KΩ	19701	RN55-D-9091F
R36	71-90	Pot., 200Ω, ±10%, 3/4 W	75042	960-290-200Ω
R37	59-1.05K	1.05 KΩ	19701	MF5C-D-1051F
R38	59-100	100Ω	19701	MF5C-D-1000F
R39	59-15.0K	15.0 KΩ	19701	RN55-D-1502F
R40	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R41	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R42	59-7.50K	7.50 KΩ	19701	RN55-D-7501F
R43	59-6.65K	6.65 KΩ	19701	RN55-D-6651F
R44	71-90	Pot, 200Ω, ±10%, 3/4 W	75042	960-290-200Ω
R45	59-3.57K	3.57 KΩ	19701	MF5C-D-3571F
R46	59-100	100Ω	19701	MF5C-D-1000F
R47	59-11.0K	11.0 KΩ	19701	RN55-D-1102F
R48	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R49	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R50	59-7.50K	7.50 KΩ	19701	RN55-D-7501F
R51	59-3.92K	3.92 KΩ	19701	MF5C-D-3921F
R52	71-90	Pot., 200Ω, ±10%, 3/4 W	75042	960-290-200Ω
R53	59-6.34K	6.34 KΩ	19701	RN55-D-6341F
R54	59-100	100Ω	19701	MF5C-D-1000F
R55	59-3.74K	3.74 KΩ	19701	MF5C-D-3741F
R56	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R57		NOT ASSIGNED		
R58		NOT ASSIGNED		
R59		NOT ASSIGNED		
R60		NOT ASSIGNED		
R61		NOT ASSIGNED		

TABLE 4-14. PARTS LIST FOR BAND CONTROL LOGIC II ASSEMBLY, A6 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R62		NOT ASSIGNED		
R63		NOT ASSIGNED		
R64		NOT ASSIGNED		
R65		NOT ASSIGNED		
R66		NOT ASSIGNED		
R67		NOT ASSIGNED		
R68		NOT ASSIGNED		
R69		NOT ASSIGNED		
R70	59-4.99K	4.99 KΩ	19701	MF5C-D-4991F
R71	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R72	59-13.0K	13.0 KΩ	19701	RN55-D-1302F
R73	59-4.99K	4.99 KΩ	19701	MF5C-D-4991F
R74	59-10.0K	10.0 KΩ	19701	RN55-D-1002
R75	59-13.0K	13.0 KΩ	19701	RN55-D-1302F
R76	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R77	59-4.99K	4.99 KΩ	19701	MF5C-D-4991F
R78	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
		INTEGRATED CIRCUITS		
U1		NOT ASSIGNED		
U2	84-1	Op. Amp.	18324	LM101A
U3	84-1	Op. Amp.	18324	LM101A
U4	84-1	Op. Amp.	18324	LM101A
U5	84-1	Op. Amp.	18324	LM101A
U6	84-1	Op. Amp.	18324	LM101A
U7	84-1	Op. Amp.	18324	LM101A
U8		NOT ASSIGNED		
U9	153-7031-001	Quad 2 Input Nand Gate	01295	SN5400N
U10	153-7035-001	Hex Inverter	18324	S5404A
U11	153-7031-001	Quad 2 Input Nand Gate	01295	SN5400N
U12	153-7031-001	Quad 2 Input Nand Gate	01295	SN5400N
U13	153-7037-001	Triple 3 Input Nand Gate	18324	S5410A
U14	153-7037-001	Triple 3 Input Nand Gate	18324	S5410A
U15	153-7035-001	Hex Inverter	18324	S5404A
U16	153-7049-001	8 Input Nand Gate	18324	S5430A
U17	153-7044-001	Monostable Multivibrator	01295	SN54121N

TABLE 4-15. PARTS LIST FOR YIG DRIVER (0.1 GHz-4GHz) ASSEMBLY, A8

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless otherwise specified, all capacitors are fixed ceramic.		
C1		NOT ASSIGNED		
C2		NOT ASSIGNED		
C3	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C4	12-47	120 pF, ±10%, 1 KV	72982	831-X5R-121K
C5	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C6		FACTORY SELECTED		
C7		NOT ASSIGNED		
C8	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C9	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C10	12-22	100 pF, ±10%, 1 KV	72982	831-000-X5F0-101K
C11	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C12	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C13	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C14	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C15	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C16	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C17		FACTORY SELECTED		
C18		FACTORY SELECTED		
C19	12-47	120 pF, ±10%, 1 KV	72982	831-X5R-121K
C20		FACTORY SELECTED		
C21		NOT ASSIGNED		
C22	12-70	150 pF, ±10%, 1 KV	71590	DD-151
C23		NOT ASSIGNED		
C24	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C25	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C26	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C27	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C28	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C29	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C30	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
		DIODES		
CR1	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR2		NOT ASSIGNED		

TABLE 4-15. PARTS LIST FOR YIG DRIVER (0.1 GHz-4GHz) ASSEMBLY, A8 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
CR3	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR4	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR5	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR6		NOT ASSIGNED		
CR7	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR8	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR9		NOT ASSIGNED		
CR10	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR11	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR12	81-20	G.P., 1A, 600 V	IND-STD	1N4005
CR13	81-20	G.P., 1A, 600 V	IND-STD	1N4005
CR14	81-20	G.P., 1A, 600 V	IND-STD	1N4005
CR15		FACTORY SELECTED		
C16	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR17	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
		FUSES		
F1	160-0009-001	Miniature, 3/4 A, 5 V	10183	GMW3/4A
F2	160-0009-001	Miniature, 3/4 A, 5 V	10183	GMW3/4A
F3	160-0008-001	Miniature, 1/2 A, 5 V	10183	GMW1/2A
		RELAY		
K1	158-0012-001	24 V, DPST	31951	220-200-24
		TRANSISTORS		
Q1	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q2		NOT ASSIGNED		
Q3	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q4	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q5	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q6		NOT ASSIGNED		
Q7	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q8	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q9	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q10		NOT ASSIGNED		
Q11	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q12	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q13		NOT ASSIGNED		

TABLE 4-15. PARTS LIST FOR YIG DRIVER (0.1 GHz-4GHz) ASSEMBLY, A8 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
Q14	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q15	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q16	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q17	153-5005-001	G.P., 100 V, 10 W, B30-130	IND-STD	2N6178
Q18	81-270	NPN, 10 A, 70 V, B20-70	04713	MJE3055
Q19	81-277	PNP, 10 A, 70 V, B20-70	04713	MJE2955
Q20		NOT ASSIGNED		
Q21		NOT ASSIGNED		
Q22	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q23	81-294	Darlington, PNP, 80 V, 70 W, B700	04713	MJE1092
Q24	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q25	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/4 W, ±1% metal film.		
R1		NOT ASSIGNED		
R2		NOT ASSIGNED		
R3		NOT ASSIGNED		
R4		NOT ASSIGNED		
R5		NOT ASSIGNED		
R6		NOT ASSIGNED		
R7		NOT ASSIGNED		
R8	59-499K	499 KΩ	19701	MF5C-D-4993F
R9	71-95	Pot., 2 KΩ, ±10%, 3/4	75042	960-290-2K
R10		FACTORY SELECTED		
R11		NOT ASSIGNED		
R12		NOT ASSIGNED		
R13		NOT ASSIGNED		
R14	59-499K	499 KΩ	19701	MF5C-D-4993F
R15	71-94	Pot., 5 KΩ, ±10%, 3/4 W	75042	960-290-5K
R16		FACTORY SELECTED		
R17	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R18	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R19	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R20		NOT ASSIGNED		

TABLE 4-15. PARTS LIST FOR YIG DRIVE (0.1GHz-4GHz) ASSEMBLY, A8 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R21	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R22	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R23		NOT ASSIGNED		
R24		NOT ASSIGNED		
R25	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R26	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R27	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R28	59-499K	499 KΩ		
R29		FACTORY SELECTED		
R30	59-499K	499 KΩ	19701	MF5C-D-4993F
R31	71-93	Pot., 10 KΩ, ±10%, 3/4 W	75042	960-290-10K
R32		FACTORY SELECTED		
R33		NOT ASSIGNED		
R34		NOT ASSIGNED		
R35		NOT ASSIGNED		
R36	59-499K	499 KΩ	19701	MF5C-D-4993F
R37	71-93	Pot., 10 KΩ, ±10%, 3/4 W	75042	960-290-10K
R38		FACTORY SELECTED		
R39	59-499K	499 KΩ	19701	MF5C-D-4993F
R40		FACTORY SELECTED		
R41		NOT ASSIGNED		
R42		NOT ASSIGNED		
R43	59-499	499 KΩ	19701	MF5C-D-4993F
R44		FACTORY SELECTED		
R45	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R46	59-1.37K	1.37 KΩ	19701	RN55-D-1371F
R47	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R48	71-90	Pot., 200Ω, ±10%, 3/4 W	75042	960-290-200Ω
R49	71-95	Pot., 2 KΩ, ±10%, 3/4 W	75042	960-290-200Ω
R50	59-44.2K	44.2 KΩ	19701	RN55-D-4422F
R51	59-51.1K	51.1 KΩ	19701	MF5C-D-5112F
R52	59-750K	750 KΩ	19701	RN55-D-7503F
R53	59-133K	133 KΩ	19701	RN55-D-1333F
R54	59-1.40K	1.40 KΩ	19701	RN55-D-1401F
R55		NOT ASSIGNED		

TABLE 4-15. PARTS LIST FOR YIG DRIVE (0.1G z-4GHz) ASSEMBLY, A8 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R56	59-15.0K	15.0 KΩ	19701	RN55-D-1502F
R57	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R58		NOT ASSIGNED		
R59		NOT ASSIGNED		
R60	59-267K	267 KΩ	19701	RN55-D-2673F
R61	59-6.98K	6.98 KΩ	19701	RN55-D-6981F
R62	59-69.8K	69.8 KΩ	19701	RN55-D-6982F
R63	59-133K	133 KΩ	19701	RN55-D-1333F
R64	59-8.06K	8.06 KΩ	19701	MF5C-D-8061F
R65		NOT ASSIGNED		
R66		NOT ASSIGNED		
R67	59-8.25K	8.25 KΩ	19701	MF5C-D-8251F
R68	59-8.25K	8.25 KΩ	19701	MF5C-D-8251F
R69	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R70	59-100K	100 KΩ	19701	MF5C-D-1003F
R71		NOT ASSIGNED		
R72	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R73	59-68.1	68.1Ω	19701	RN55-D-68R1F
R74	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R75	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R76		NOT ASSIGNED		
R77	59-909	909Ω	19701	RN55-D-9090F
R78	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R79	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R80	61-42	5Ω, ±1%, 5 W, WW	91637	RH-5-5.0Ω
R81	59-909	909Ω	19701	RN55-D-9090F
R82		NOT ASSIGNED		
R83	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R84	44-1.5	1.5Ω, ±5%, 2 W, WW	75042	BWH1.5Ω±5%
R85	59-1.69	1.69 KΩ	19701	RN55-D-1691F
R86	59-169	169Ω	19701	MF5C-D-1690F
R87	59-15.0K	15.0 KΩ	19701	RN55-D-1502F
R88	59-3.83K	3.83 KΩ	19701	RN55-D-3831F
R89		FACTORY SELECTED		
R90	71-91	Pot., 500Ω, ±10%, 3/4 W	75042	960-290-500Ω

TABLE 4-15. PARTS LIST FOR YIG DRIVE (0.1GHz-4GHz) ASSEMBLY, A8 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R91	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R92	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R93	71-95	Pot., 2KΩ, ±10%, 3/4 W	75042	960-290-2K
R94		FACTORY SELECTED		
R95	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R96	59-1.50K	1.50 KΩ	19701	MF5C-D-1501F
R97	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R98	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R99		FACTORY SELECTED		
R100	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R101	59-69.8	69.8Ω	19701	RN55-D-69R8F
		INTEGRATED CIRCUITS		
U1		NOT ASSIGNED		
U2	84-1	Op. Amp.	18324	LM101A
U3	153-7056-001	Op. Amp.	13919	3500A
U4	84-1	Op. Amp.	18324	LM101A

TABLE 4-16. PARTS LIST FOR VTO DRIVER (4GHz-8GHz) ASSEMBLY, A9

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless otherwise specified, all capacitors are fixed ceramic.		
C1		NOT ASSIGNED		
C2		NOT ASSIGNED		
C3		NOT ASSIGNED		
C4	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C5	12-21	27 pF, ±5%, 1 KV	72982	831-U2M-270K
C6	12-2	0.001μF, ±10%, 1 KV	72982	851-X5R-102K
C7	12-70	150 pF, ±10%, 1 KV	71590	DD-151
C8	12-7	5 pF, ±20%, 1 KV	56289	5GA-V50
C9	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C10	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C11	150-5023-001	33μF, -10% +100%, 50 V	14655	BRNP-50-50
C12	13-89	100μF, ±20%, 20 V, fixed Tant.	56289	196D107X0020MA3
C13		NOT ASSIGNED		
C14	12-47	120 pF, ±10%, 1 KV	72982	831-X5R-121K
C15	12-70	150 pF, ±10%, 1 KV	71590	DD-151
C16	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C17	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C18	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C19	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C20	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C21	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C22		NOT ASSIGNED		
C23	12-18	200 pF, ±10%, 600 V	72982	831-X550-201K
C24	12-73	0.047μF, ±20%, 50 V	72982	8131-651-473M
		DIODES		
CR1	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR2	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR3	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR4	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR5	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR6	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR7	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR8	81-77	Zener, 5.6 V, ±5%, 1 W	IND-STD	1N4734A

TABLE 4-16. PARTS LIST FOR VTO DRIVER (4GHz-8GHz) ASSEMBLY, A9 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
CR9	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR10	81-77	Zener, 5.6 V, ±5%, 1 W	IND-STD	1N4734A
CR11	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR12	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR13	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR14	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR15	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR16	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR17	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR18	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR19	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR20	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR21	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR22	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR23	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR24	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR25	81-275	Zener, 18 V, ±5%, 1 W	IND-STD	1N4746A
		RELAY		
K1	106-53	SPST, 24 V	31951	220-100-24
		TRANSISTORS		
Q1	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q2	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q3	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q4	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q5	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q6	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q7	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q8	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q9	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q10	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q11	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q12	153-3023-001	NPN, 150 VC Max, 300 mW, B80-300	IND-STD	2N4889
Q13	153-3023-001	NPN, 150 VC Max, 300 mW, B80-300	IND-STD	2N4889
Q14	153-3033-001	PNP, 150 VC Max, 700 mW, B50	IND-STD	2N5964
Q15	153-3023-001	NPN, 150 VC Max, 300 mW, B80-300	IND-STD	2N4889

TABLE 4-16. PARTS LIST FOR VTO DRIVER (4GHz-8GHz) ASSEMBLY, A9 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
Q16	556-154-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q17	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q18	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q19	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q20	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q21	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q22	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q23	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q24	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q25	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q26	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q27	81-294	Darlington, PNP, 80 V, 70 W, B700	04713	MJE1092
Q28	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q29	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/4 W, ±1% metal film.		
R1		NOT ASSIGNED		
R2		NOT ASSIGNED		
R3		NOT ASSIGNED		
R4		NOT ASSIGNED		
R5		NOT ASSIGNED		
R6		NOT ASSIGNED		
R7		NOT ASSIGNED		
R8	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R9	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R10	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R11	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R12	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R13	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R14	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R15	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R16	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R17		NOT ASSIGNED		
R18	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F

TABLE 4-16. PARTS LIST FOR VTO DRIVER (4GHz-8GHz) ASSEMBLY, A9 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R19	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R20	59-499K	499 KΩ	19701	MF5C-D-4993F
R21	59-499K	499 KΩ	19701	MF5C-D-4993F
R22		FACTORY SELECTED		
R23	71-95	Pot., 2 KΩ, ±10%, 3/4 W	75042	960-290-2K
R24	59-499K	499 KΩ	19701	MF5C-D-4993F
R25		NOT ASSIGNED		
R26	59-499K	499 KΩ	19701	MF5C-D-4993K
R27	71-91	Pot., 500Ω, ±10%, 3/4 W	75042	960-290-500Ω
R28	59-4.75K	4.75 KΩ	19701	MF5C-D-4751F
R29	59-30.1K	30.1 KΩ	19701	RN55-D-3012F
R30	59-45.3K	45.3 KΩ	19701	RN55-D-4532F
R31	59-20.0K	20.0 KΩ	19701	RN55-D-2002F
R32		NOT ASSIGNED		
R33		FACTORY SELECTED		
R34	59-499K	499 KΩ	19701	MF5C-D-4993F
R35	59-8.25K	8.25 KΩ	19701	MF5C-D-8251F
R36	71-105	Pot., 1 KΩ, ±10%, 3/4 W	75042	960-290-1K
R37	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R38	59-499K	499 KΩ	19701	MF5C-D-4993F
R39	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R40	71-105	Pot., 1 KΩ, ±10%, 3/4 W	75042	960-290-1K
R41	59-8.25K	8.25 KΩ	19701	MF5C-D-8251F
R42	59-8.25K	8.25 KΩ	19701	MF5C-D-8251F
R43	59-499K	499 KΩ	19701	MF5C-D-4993F
R44	71-105	Pot., 1 KΩ, ±10%, 3/4 W	75042	960-290-1K
R45	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R46		FACTORY SELECTED		
R47		FACTORY SELECTED		
R48	59-100K	100 KΩ	19701	MF5C-D-1003F
R49	59-36.5K	36.5 KΩ	19701	MF5C-D-3652F
R50	59-115K	115 KΩ	19701	RN55-D-1153F
R51	59-54.9K	54.9 KΩ	19701	MF5C-D-5492F
R52	59-49.9K	49.9 KΩ	19701	MF5C-D-4992F
R53		FACTORY SELECTED		

TABLE 4-16. PARTS LIST FOR VTO DRIVER (4GHz-8GHz) ASSEMBLY, A9 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R54		FACTORY SELECTED		
R55	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R56	59-2.49K	2.49 KΩ	19701	RN55-D-2491F
R57	59-4.99K	4.99 KΩ	19701	MF5C-D-4991F
R58	59-825	825Ω	19701	RN55-D-8250F
R59	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R60	59-22.1K	22.1 KΩ	19701	RN55-D-2212F
R61	59-4.02K	4.02 KΩ	19701	RN55-D-4021F
R62	59-49.9	49.9Ω	19701	RN55-D-49R9F
R63	59-499K	499 KΩ	19701	MF5C-D-4993F
R64	55-23.7K	23.7 KΩ	19071	RN55-D-2372F
R65	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R66	59-20.0K	20.0 KΩ	19701	MF5C-D-2002F
R67	59-30.1K	30.1 KΩ	19701	RN55-D-3012F
R68	59-30.1K	30.1 KΩ	19701	RN55-D-3012F
R69	59-1.91K	1.91 KΩ	19701	RN55-D-1911F
R70	59-80.6	80.6Ω	19701	RN55-D-80R6F
R71	59-13.3K	13.3 KΩ	19701	RN55-D-1332F
R72	71-105	Pot., 1 KΩ, ±10%, 3/4 W	75042	960-290-1K
R73		FACTORY SELECTED		
R74		FACTORY SELECTED		
R75	59-16.9K	16.9 KΩ	19701	RN55-D-1692F
R76	59-12.4K	12.4 KΩ	19701	RN55-D-1242F
R77	71-105	Pot., 1 KΩ, ±10%, 3/4 W	75042	960-290-1K
R78		FACTORY SELECTED		
R79		FACTORY SELECTED		
R80	59-16.9K	16.9 KΩ	19701	RN55-D-1692F
R81	59-11.5K	11.5 KΩ	19701	RN55-D-1152F
R82	71-105	Pot., 1 KΩ, ±10%, 3/4 W	75042	960-290-1K
R83		FACTORY SELECTED		
R84		FACTORY SELECTED		
R85	59-18.7K	18.7 KΩ	19701	RN55-D-1872F
R86	59-11.0K	11.0 KΩ	19701	MF5C-D-1102F
R87	71-105	Pot., 1 KΩ, ±10%, 3/4 W	75042	960-290-1K
R88		FACTORY SELECTED		

TABLE 4-16. PARTS LIST FOR VTO DRIVER (4GHz-8GHz) ASSEMBLY, A9 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R89		FACTORY SELECTED		
R90	59-18.7K	18.7 KΩ	19701	RN55-D-1872F
R91	59-11.0K	11.0 KΩ	19701	MF5C-D-1102F
R92	71-105	Pot., 1 KΩ, ±10%, 3/4 W	75042	960-290-1K
R93		FACTORY SELECTED		
R94	59-20.0K	20.0 KΩ	19701	MF5C-D-2002F
R95		FACTORY SELECTED		
R96	59-12.4K	12.4 KΩ	19701	RN55-D-1242F
R97	71-105	Pot., 1 KΩ, ±10%, 3/4 W	75042	960-290-1K
R98		FACTORY SELECTED		
R99	59-20.0K	20.0 KΩ	19701	MF5C-D-2002F
R100		FACTORY SELECTED		
R101	59-14.3K	14.3 KΩ	19701	RN55-D-1432F
R102	71-105	Pot., 1 KΩ, ±10%, 3/4 W	75042	960-290-1K
R103		FACTORY SELECTED		
R104		NOT ASSIGNED		
R105		FACTORY SELECTED		
R106	59-15.8K	15.8 KΩ	19701	RN55-D-1582F
R107	71-105	Pot., 1 KΩ, ±10%, 3/4 W	75042	960-290-1K
R108		FACTORY SELECTED		
R109	59-22.1K	22.1 KΩ	19701	RN55-D-2212F
R110		FACTORY SELECTED		
R111	59-17.4K	17.4 KΩ	19701	MF5C-D-1742F
R112	71-105	Pot., 1 KΩ, ±10%, 3/4 W	75042	960-290-1K
R113		FACTORY SELECTED		
R114	59-22.1K	22.1 KΩ	19701	RN55-D-2212F
R115		FACTORY SELECTED		
R116	59-19.6K	19.6 KΩ	19701	MF5C-D-1962F
R117	71-105	Pot., 1 KΩ, ±10%, 3/4 W	75042	960-290-1K
R118		FACTORY SELECTED		
R119	59-22.1K	22.1 KΩ	19701	RN55-D-2212F
R120		FACTORY SELECTED		
R121	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R122	59-15.0K	15.0 KΩ	19701	RN55-D-1502F
R123	44-1	1.0Ω, ±5%, 1/2 W, WW	75042	BWH-1.0Ω-±5%

TABLE 4-16. PARTS LIST FOR VTO DRIVER (4GHz-8GHz) ASSEMBLY, A9 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R124	59-1.69K	1.69 KΩ	19701	RN55-D-1691F
R125	59-169	169Ω	19701	RN55-D-1690F
R126	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R127	59-16.9K	16.9 KΩ	19707	RN55-D-1692F
R128	59-2.21K	2.21 KΩ	19701	MF5C-C-2211F
R129	71-91	Pot., 500Ω, ±10%, 3/4 W	75042	960-290-500Ω
R130	59-14.7K	14.7 KΩ	19701	RN55-D-1472F
R131	59-4.99K	4.99 KΩ	19701	MF5C-D-4991F
R132	59-6.19K	6.19 KΩ	19701	RN55-D-6191F
R133	59-5.49K	5.49 KΩ	19701	MF5C-D-5491F
R134	59-20.0K	20.0 KΩ	19701	MF5C-D-2002F
R135	59-2.00K	2.00 KΩ	19701	MF5C-D-2001F
		INTEGRATED CIRCUIT		
U1		NOT ASSIGNED		
U2	153-7056-001	Op. Amp.	13919	3500A
U3	84-1	Op. Amp.	18324	LM101A
U4	84-1	Op. Amp.	18324	LM101A

TABLE 4-17. PARTS LIST FOR YIG DRIVER (4GHz-8GHz) ASSEMBLY, A9

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless otherwise specified, all capacitors are fixed ceramic.		
C1		NOT ASSIGNED		
C2		NOT ASSIGNED		
C3	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C4	12-47	120 pF, ±10%, 1 KV	72982	831-X5R-121K
C5	12-56	0.01μF, ±20%, 25 V	71590	UK25-103
C6		FACTORY SELECTED		
C7		NOT ASSIGNED		
C8	12-82	0.47μF, ±20%, 100 V	56289	CY30A474M
C9	13-91	33μF, ±20%, 25 V, fixed Tant	75042	196D336X0025LA3
C10	12-22	100 pF, ±10%, 1 KV	72982	831-000-X5F0-101K
C11	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C12	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C13	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C14	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C15	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C16	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C17		FACTORY SELECTED		
C18		FACTORY SELECTED		
C19	12-47	120 pF, ±10%, 1 KV	72982	831-X5R-121K
C20	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C21		NOT ASSIGNED		
C22	12-70	150 pF, ±10%, 1 KV	71590	DD-151
C23		NOT ASSIGNED		
C24	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C25	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C26	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C27	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C28	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C29	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C30	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
		DIODES		
CR1	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR2	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148

TABLE 4-17. PARTS LIST FOR YIG DRIVER (4GHz-8GHz) ASSEMBLY, A9 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
CR3	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR4		NOT ASSIGNED		
CR5	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR6	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR7	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR8	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR9	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR10	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR11	154-0013-001	G.P., 10 mA, 75V	IND-STD	1N4148
CR12	81-20	G.P., 1 A, 600 V	IND-STD	1N4005
CR13	81-20	G.P., 1 A, 600 V	IND-STD	1N4005
CR14	81-20	G.P., 1 A, 600 V	IND-STD	1N4005
CR15		FACTORY SELECTED		
CR16	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR17	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
		FUSES		
F1	160-0009-001	Min., 3/4 Amp.	10133	GMW-3/4A
F2	160-0009-001	Min., 3/4 Amp.	10133	GMW-3/4A
F3	160-0008-001	Min., 1/2 Amp.	10133	GMW-3/4A
		RELAY		
K1	158-0012-001	DPST, 24 V	31951	
		TRANSISTORS		
Q1	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q2	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q3	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q4	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q5	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q6	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q7	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q8	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q9	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q10	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q11	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q12	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q13	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175

TABLE 4-17. PARTS LIST FOR YIG DRIVER (4GHz-8GHz) ASSEMBLY, A9 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
Q14	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q15	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q16	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q17	153-5005-001	G.P., 100 V, 10 W, B30-130	IND-STD	2N6178
Q18	81-270	NPN, 10 A, 70 V, B20-70 MF	04713	MJE3055
Q19	31-277	NPN, 10 A, 70 V, B20-70 MF	04713	MJE2955
Q20		NOT ASSIGNED		
Q21		NOT ASSIGNED		
Q22	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q23	81-294	Darlington, PNP, 80 V, 70 W, B700	04713	MJE1092
Q24	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q25	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q26		NOT ASSIGNED		
Q27		NOT ASSIGNED		
Q28	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/4 W, ±1% metal film.		
R1		NOT ASSIGNED		
R2		NOT ASSIGNED		
R3		NOT ASSIGNED		
R4		NOT ASSIGNED		
R5		NOT ASSIGNED		
R6		NOT ASSIGNED		
R7		NOT ASSIGNED		
R8	59-499K	499 KΩ	19701	MF5C-D-4993F
R9	71-94	Pot., 5 KΩ, ±10%, 3/4 W	75042	960-290-5K
R10		FACTORY SELECTED		
R11	59-499K	499 KΩ	19701	MF5C-D-4993F
R12	71-93	Pot., 10 KΩ, ±10%, 3/4 W	75042	960-290-10K
R13		FACTORY SELECTED		
R14	59-499K	499 KΩ	19701	MF5C-D-4993F
R15	71-94	Pot., 5 KΩ, ±10%, 3/4 W	75042	960-290-5K
R16		FACTORY SELECTED		
R17	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F

TABLE 4-17. PARTS LIST FOR YIG DRIVER (4GHz-8GHz) ASSEMBLY, A9 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R18	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R19	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R20	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R21	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R22	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R23	59-3.32K	3.32 KΩ	19701	MF5C-D-3221F
R24	59-3.32K	3.32 KΩ	19701	MF5C-D-3221F
R25	59-3.32K	3.32 KΩ	19701	MF5C-D-3221F
R26	59-3.32K	3.32 KΩ	19701	MF5C-D-3221F
R27	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R28	59-499K	499 KΩ	19701	MF5C-D-4993F
R29		FACTORY SELECTED		
R30	59-499K	499 KΩ	19701	MF5C-D-4993F
R31	71-146	Pot., 20 KΩ, ±10%, 3/4 W	75042	960-290-20K
R32		FACTORY SELECTED		
R33	59-499K	499 KΩ	19701	MF5C-D-4993F
R34	71-153	Pot., 50 KΩ, ±10%, 3/4 W	75042	960-290-50K
R35		FACTORY SELECTED		
R36	59-499K	499 KΩ	19701	MF5C-D-4993F
R37	71-153	Pot., 50 KΩ, ±10%, 3/4 W	84048	960-290-50K
R38		NOT ASSIGNED		
R39	59-499K	499 KΩ	19701	MF5C-D-4993F
R40		FACTORY SELECTED		
R41	59-499K	499 KΩ	19701	MF5C-D-4993F
R42		FACTORY SELECTED		
R43	59-499K	499 KΩ	19701	MF5C-D-4993F
R44		FACTORY SELECTED		
R45	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R46	59-1.37K	1.37 KΩ	19701	RN55-D-1371F
R47	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R48	71-90	Pot., 200Ω, ±10%, 3/4 W	19701	960-290-200Ω
R49	71-95	Pot., 2 KΩ, ±10%, 3/4 W	75042	960-290-2K
R50	59-44.2K	44.2 KΩ	19701	RN55-D-4422F
R51	59-51.1K	51.1 KΩ	19701	MF5C-D-5112F
R52	59-705K	750 KΩ	19701	RN55-D-7503F

TABLE 4-17. PARTS LIST FOR YIG DRIVER (4GHz-8GHz) ASSEMBLY, A9 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R53	59-133K	133 KΩ	19701	RN55-D-1333F
R54	59-1.40K	1.40 KΩ	19701	RN55-D-1401F
R55		NOT ASSIGNED		
R56	59-15.0K	15.0 KΩ	19701	RN55-D-1502F
R57	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R58		NOT ASSIGNED		
R59		NOT ASSIGNED		
R60	59-267K	267 KΩ	19701	RN55-D-2673F
R61	59-30.1K	30.1 KΩ	19701	RN55-D-3012F
R62	59-140K	140 KΩ	19701	RN55-D-1403F
R63	59-133K	133 KΩ	19701	RN55-D-1333F
R64	59-30.1K	30.1 KΩ	19701	RN55-D-3012F
R65		NOT ASSIGNED		
R66		NOT ASSIGNED		
R67	59-8.25K	8.25 KΩ	19701	MF5C-D-8251F
R68	59-8.25K	8.25 KΩ	19701	MF5C-D-8251F
R69	59-30.1K	30.1 KΩ	19701	RN55-D-3012F
R70	59-249K	249 KΩ	19701	MF5C-D-2493F
R71		NOT ASSIGNED		
R72	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R73	59-68.1	68.1Ω	19701	RN55-D-68R1F
R74	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R75	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R76		NOT ASSIGNED		
R77	59-909	909Ω	19701	RN55-D-9090F
R78	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R79	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R80	61-46	2Ω, ±3%, 5 W, WW, MF	91637	RH-5-2.0Ω
R81	59-909	909Ω	19701	RN55-D-9090F
R82		NOT ASSIGNED		
R83	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R84	44-1.5	1.5Ω, ±5%, 2 W, WW	75042	BWH 1.5Ω±5%
R85	59-1.69K	1.69 KΩ	19701	RN55-D-1691F
R86	59-169	169Ω	19701	MF5C-D-1690F
R87	59-16.9K	16.9 KΩ	19701	RN55-D-1692F

TABLE 4-17. PARTS LIST FOR YIG DRIVER (4GHz-8GHz) ASSEMBLY, A9 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R88	59-3.83K	3.83 KΩ	19701	RN55-D-3831F
R89		FACTORY SELECTED		
R90	71-91	Pot., 500Ω, ±10%, 3/4 W	75042	960-290-500
R91	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R92	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R93	71-95	Pot., 2 KΩ, ±10%, 3/4 W	75042	960-290-2K
R94		FACTORY SELECTED		
R95	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R96	59-1.50K	1.50 KΩ	19701	MF5C-D-1501F
R97	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R98	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R99		FACTORY SELECTED		
R100	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R101	59-20.0	20.0Ω	19701	MF5C-D-20R0F
		INTEGRATED CIRCUITS		
U1		NOT ASSIGNED		
U2	84-1	Op. Amp.	18324	LM101A
U3	153-7056-001	Op. Amp.	13919	3500A
U4	84-1	Op. Amp.	18324	LM101A

TABLE 4-18. PARTS LIST FOR YIG DRIVER (8GHz-12.4GHz) ASSEMBLY, A10

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless otherwise specified, all capacitors are fixed ceramic.		
C1		NOT ASSIGNED		
C2		NOT ASSIGNED		
C3	12-82	0.47µF, ±20%, 1 DOV	88245	CY30A474M
C4	12-47	120 pF, ±10%, 1 KV	72982	831-X5R-121K
C5	12-56	0.01µF, ±20%, 25 V	56289	C069B250E103Z
C6		FACTORY SELECTED		
C7		NOT ASSIGNED		
C8	12-82	0.47µF, ±20%, 100 V	88245	CY30A474M
C9	13-91	33µF, ±20%, 25 V, fixed Tant.	56289	196D336X0025LA3
C10	12-22	100 pF, ±10%, 1 KV	72982	831-000-X5F0-101K
C11	13-98	220µF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C12	13-98	220µF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C13	13-98	220µF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C14	13-98	220µF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C15	13-98	220µF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C16	13-98	220µF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C17		FACTORY SELECTED		
C18		FACTORY SELECTED		
C19	12-47	120 pF, ±10%, 1 KV	72982	831-X5R-12
C20	13-89	100µF, ±20%, 20 V, fixed Tant.	56289	196D107X0020M
C21		NOT ASSIGNED		
C22	12-70	150 pF, ±10%, 1 KV	71590	DD-151
C23		NOT ASSIGNED		
C24	12-100	10µF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C25	12-100	10µF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C26	12-100	10µF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C27	12-82	0.47µF, ±20%, 100 V	88245	CY30A474M
C28	12-100	10µF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C29	12-100	10µF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C30	12-100	10µF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
		DIODES		
CR1	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR2	154-0013-00-	G.P., 10 mA, 75 V	IND-STD	1N4148

TABLE 4-18. PARTS LIST FOR YIG DRIVER (8GHz-12.4GHz) ASSEMBLY, A10 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
CR3	154-0013-001	G.P., 10 mA, 75 V		
CR4	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR5	154-0013-001	G.P., 10 mA, 75 V		
CR6	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR7	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR8	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR9	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR10	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR11	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR12	81-20	G.P., 1 A, 600 V	IND-STD	1N4005
CR13	81-20	G.P., 1 A, 600 V	IND-STD	1N4005
CR14	81-20	G.P., 1 A, 600 V	IND-STD	1N4005
CR15		FACTORY SELECTED		
CR16	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR17	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
		FUSES		
F1	160-0010-001	Min., 1 A	10133	GMW1A
F2	160-0010-001	Min., 1 A	10133	GMW1A
F3	160-0011-001	Min., 1.5 A	10133	GMW1.5A
		RELAY		
K1	158-0012-001	2 PST Reed, 24 V	31951	220-200-2
		TRANSISTORS		
Q1	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q2	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q3	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q4	156-446-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q5	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q6	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q7	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q8	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q9	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q10	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q11	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q12	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q13	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175

TABLE 4-18. PARTS LIST FOR YIG DRIVER (8GHz-12.4GHz) ASSEMBLY, A10 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
Q14	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q15	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q16	556-146-998	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q17	153-5005-001	G.P., 100 V, 10 W, B30-130	IND-STD	2N6178
Q18	81-270	NPN, 10 A, 70 V, B20-70 MF	04713	MJE3055
Q19	81-277	PNP, 10 A, 70 V, B20-70 MF	04713	MJE2955
Q20		NOT ASSIGNED		
Q21		NOT ASSIGNED		
Q22	556-146-988	PNP, 40 VC Max, 0.31 W, R100-300	IND-STD	2N3906
Q23	81-294	Darlington, PNP, 80 V, 70 W, B700	04713	MJE1092
Q24	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q25	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/4 W, ±1% metal film.		
R1		NOT ASSIGNED		
R2		NOT ASSIGNED		
R3		NOT ASSIGNED		
R4		NOT ASSIGNED		
R5		NOT ASSIGNED		
R6		NOT ASSIGNED		
R7		NOT ASSIGNED		
R8	59-499K	499 KΩ	19701	MF5C-D-4993F
R9	71-94	Pot., 5 KΩ, ±10%, 3/4 W	75042	960-290-5K
R10		FACTORY SELECTED		
R11	59-499K	499 KΩ	19701	MF5C-D-4993F
R12	71-146	Pot., 20 KΩ, ±10%, 1/2 W	75042	960-290-20K
R13		FACTORY SELECTED		
R14	59-499K	499 KΩ	19701	MF5C-D-4993K
R15	71-94	Pot., 5 KΩ, ±10%, 3/4 W	75042	960-290-5K
R16		FACTORY SELECTED		
R17	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R18	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R19	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R20	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F

TABLE 4-18. PARTS LIST FOR YIG DRIVER (8GHz-12.4GHz) ASSEMBLY, A10 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R21	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R22	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R23	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R24	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R25	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R26	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R27	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R28	59-499K	499 KΩ	19701	MF5C-D-4993F
R29		FACTORY SELECTED		
R30	59-499K	499 KΩ	19701	MF5C-D-4993F
R31	71-93	Pot., 10 KΩ, ±10%, 3/4 W	75042	960-290-10K
R32		FACTORY SELECTED		
R33	59-499K	499 KΩ	19701	MF5C-D-4993F
R34	71-146	Pot., 20 KΩ, ±10%, 1/2 W	75042	960-290-20K
R35		FACTORY SELECTED		
R36	59-499K	499 KΩ	19701	MF5C-D-4993K
R37	71-153	Pot., 50 KΩ, ±10%, 1.2 W	84048	960-290-50K
R38		NOT ASSIGNED		
R39	59-499K	499 KΩ	19701	MF5C-D-4993F
R40		FACTORY SELECTED		
R41	59-499K	499 KΩ	19701	MF5C-D-4993F
R42		FACTORY SELECTED		
R43	59-499K	499 KΩ	19701	MF5C-D-4993F
R44		FACTORY SELECTED		
R45	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R46	59-1.37K	1.37 KΩ	19701	RN55-D-1371F
R47	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R48	71-90	Pot., 200Ω, ±10%, 3/4 W	75042	960-290-200
R49	71-95	Pot., 2 KΩ, ±10%, 3/4 W	75042	960-290-2K
R50	59-44.2K	44.2 KΩ	19701	RN55-D-4422F
R51	59-51.1K	51.1 KΩ	19701	MF5C-D-5112F
R52	59-750K	750 KΩ	19701	RN60-D-7503F
R53	59-133K	133 KΩ	19701	RN55-D-1333F
R54	59-1.40K	1.40 KΩ	19701	RN55-D-1401F
R55		NOT ASSIGNED		

TABLE 4-18. PARTS LIST FOR YIG DRIVER (8GHz-12.4GHz) ASSEMBLY, A10 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R56	59-15.0K	15.0 KΩ	19701	RN55-D-1502F
R57	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R58		NOT ASSIGNED		
R59		NOT ASSIGNED		
R60	59-276K	267 KΩ	19701	RN55-D-2673F
R61	59-22.1K	22.1 KΩ	19701	RN55-D-2212F
R62	59-80.6K	80.6 KΩ	19701	RN55-D-8062F
R63	59-133K	133 KΩ	19701	RN55-D-1333F
R64	59-30.1K	30.1 KΩ	19701	RN55-D-3012F
R65		NOT ASSIGNED		
R66		NOT ASSIGNED		
R67	59-8.25K	8.25 KΩ	19701	MF5C-D-8251F
R68	59-8.25K	8.25 KΩ	19701	MF5C-D-8251F
R69	59-30.1K	30.1 KΩ	19701	RN55-D-3012F
R70	59-249K	249 KΩ	19701	MF5C-D-2493F
R71		NOT ASSIGNED		
R72	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R73	59-68.1	68.1	19701	RN55-D-68R1F
R74	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R75	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R76		NOT ASSIGNED		
R77	59-909	909Ω	19701	RN55-D-9090F
R78	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R79	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R80	61-46	2Ω, ±3%, 5 W, WW	91637	RH-5-2.0Ω
R81	59-909	909Ω	19701	RN55-D-9090F
R82		NOT ASSIGNED		
R83	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R84	44-.33	0.33Ω, ±5%, 1/2 W, WW	75042	BWH, .33 ±5%
R85	59-1.69K	1.69KΩ	19701	RN55-D-1691F
R86	59-169	169Ω	19701	MF5C-D-1691F
R87	59-17.4K	17.4 KΩ	19701	RN55-D-1742F
R88	59-3.83K	3.83 KΩ	19701	RN55-D-3831F
R89		FACTORY SELECTED		
R90	71-91	Pot., 500Ω, ±10%, 3/4 W	75042	960-290-500

TABLE 4-18. PARTS LIST FOR YIG DRIVER (8GHz-12.4GHz) ASSEMBLY, A10 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R91	59-2.21K	2.21 KΩ	19701	MF5C-D-2211K
R92	59-2.22K	2.21 KΩ	19701	MF5C-D-2211F
R93	71-95	Pot., 2 KΩ, ±10%, 3/4 W	75042	960-290-2K
R94		FACTORY SELECTED		
R95	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R96	59-1.50K	1.50 KΩ	19701	MF5C-D-15
R97	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R98	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R99		FACTORY SELECTED		
R100	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R101	59-20.0	20.0Ω	19701	MF5C-D-20R0F
		INTEGRATED CIRCUITS		
U1		NOT ASSIGNED		
U2	84-1	Op. Amp.	13324	LM101A
U3	153-7056-001	Op. Amp.	13919	3500A
U4	84-1	Op. Amp	18324	LM101A

TABLE 4-19. PARTS LIST FOR YIG DRIVER (12.4 GHz-18 GHz) ASSEMBLY, A11

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless otherwise specified, all capacitors are fixed ceramic.		
C1		NOT ASSIGNED		
C2		NOT ASSIGNED		
C3	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C4	12-47	120 pF, ±10%, 1 KV	72982	831-X5R-121K
C5	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C6		FACTORY SELECTED		
C7		NOT ASSIGNED		
C8	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C9	13-91	33μF, ±20%, 25 V, fixed Tant.	56289	196D336X0025LA3
C10	12-22	100 pF, ±10%, 1 KV	72982	831-000-X5F0-101
C11	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C12	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C13	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C14	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C15	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C16	13-98	220μF, ±20%, 10 V, fixed Tant.	56289	196P228X001TE4
C17		FACTORY SELECTED		
C18		FACTORY SELECTED		
C19	12-47	120 pF, ±10%, 1 KV	72982	831-X5R-121K
C20	13-89	100μF, ±20%, 20 V, fixed Tant.	56289	196D107X0020MA3
C21		NOT ASSIGNED		
C22	12-70	150 pF, ±10%, 1 KV	71590	DD-151
C23		NOT ASSIGNED		
C24	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C25	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C26	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C27	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C28	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C29	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C30	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
		DIODES		
CR1	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR2	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR3		NOT ASSIGNED		

TABLE 4-19. PARTS LIST FOR YIG DRIVER (12.4 GHz-18 GHz) ASSEMBLY, A11 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
CR4	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR5		NOT ASSIGNED		
CR6	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR7	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR8	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR9	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR10		NOT ASSIGNED		
CR11	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR12	81-328	3A, 400 V	14099	3SI6
CR13	81-20	G.P., 1A, 600 V	IND-STD	1N4005
CR14	81-20	G.P., 1A, 600 V	IND-STD	1N4005
CR15		FACTORY SELECTED		
CR16	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR17	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
		FUSES		
F1	160-0011-001	Min., 1.5 A	10133	GMW 1.5 A
F2	160-0011-001	Min., 1.5 A	10133	GMW 1.5 A
F3	160-0011-001	Min., 1.5 A	10133	GMW 1.5 A
		RELAY		
K1	158-0012-001	2 PST Reed, 24 V	31951	220-200-24
		TRANSISTORS		
Q1	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q2	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q3		NOT ASSIGNED		
Q4	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q5		NOT ASSIGNED		
Q6	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q7	556-149-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q8	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q9		NOT ASSIGNED		
Q10	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q11	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q12	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q13	153-4003-001	FET Switching, 350 mW, 6.0 V	17896	E-175
Q14		NOT ASSIGNED		
Q15	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906

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TABLE 4-19. PARTS LIST FOR YIG DRIVER (12.4 GHz-18 GHz) ASSEMBLY, A11 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
Q16	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q17	153-5005-001	G.P., 100 V, 10 W, B30-130	IND-STD	2N6178
Q18	81-270	NPN, 10 A, 70 V, B20-70, MF	04713	MJE3055
Q19	81-277	PNP, 10 A, 70 V, B20-70, MF	04173	MJE2955
Q20		NOT ASSIGNED		
Q21		NOT ASSIGNED		
Q22	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q23	81-294	Darlington, PNP, 40 V, 70 W, B700	04713	MJE1092
Q24	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q25	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/4 W, ±1% metal film.		
R1		NOT ASSIGNED		
R2		NOT ASSIGNED		
R3		NOT ASSIGNED		
R4		NOT ASSIGNED		
R5		NOT ASSIGNED		
R6		NOT ASSIGNED		
R7		NOT ASSIGNED		
R8	59-499K	499 KΩ	19701	MF5C-D-4993F
R9	71-94	Pot., 5 KΩ, ±10%, 3/4 W	75042	960-290-2K
R10		FACTORY SELECTED		
R11	59-499K	499 KΩ	19701	MF5C-D-4993F
R12	71-146	Pot., 20 KΩ, ±10%, 3/4 W	75042	960-290-20K
R13		FACTORY SELECTED		
R14		NOT SELECTED		
R15		NOT SELECTED		
R16		NOT SELECTED		
R17	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R18		NOT ASSIGNED		
R19	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R20	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R21		NOT ASSIGNED		
R22		NOT ASSIGNED		
R23	59-3.32K	3.32 KΩ	19701	MF5C-D-3221F

TABLE 4-19. PARTS LIST FOR YIG DRIVER (12.4 GHz-18 GHz) ASSEMBLY, A11 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R24	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R25	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R26	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R27	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R28	59-499K	499 KΩ	19701	MF5C-D-4993F
R29		FACTORY SELECTED		
R30		NOT ASSIGNED		
R31		NOT ASSIGNED		
R32		NOT ASSIGNED		
R33	59-499K	499 KΩ	19701	MF5C-D-4993F
R34	71-93	Pot., 10 KΩ, ±10%, 3/4 W	75042	960-290-10K
R35		FACTORY SELECTED		
R36	59-499K	499 KΩ	19701	MF5C-D-4993F
R37	71-129	Pot., 100 KΩ, ±10%, 3/4 W	75042	960-290-100K
R38		FACTORY SELECTED		
R39	59-499K	499 KΩ	19701	MF5C-D-4993F
R40		FACTORY SELECTED		
R41	59-499K	499 KΩ	19701	MF5C-D-4993F
R42		FACTORY SELECTED		
R43		NOT ASSIGNED		
R44		NOT ASSIGNED		
R45	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R46	59-1.37K	1.37 KΩ	19701	RN55-D-1371F
R47	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R48	71-90	Pot., 200Ω, ±10%, 3/4 W	75042	960-290-200Ω
R49	71-95	Pot., 2 KΩ, ±10%, 3/4 W	75042	960-290-2K
R50	59-44.2K	44.2 KΩ	19701	RN55-D-4422F
R51	59-51.1K	51.1 KΩ	19701	MF5C-D-5112F
R52	59-750K	750 KΩ	19701	RN60-D-7503F
R53	59-133K	133 KΩ	19701	RN55-D-1333F
R54	59-1.40K	1.40 KΩ	19701	RN55-D-1401F
R55		NOT ASSIGNED		
R56	59-15.0K	15.0 KΩ	19701	RN55-D-1502F
R57	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R58		NOT ASSIGNED		
R59		NOT ASSIGNED		

TABLE 4-19. PARTS LIST FOR YIG DRIVER (12.4 GHz-18 GHz) ASSEMBLY, A11 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R60	59-267K	267 KΩ	19701	RN55-D-2673F
R61	59-23.7K	23.7 KΩ	19701	RN55-D-2372F
R62	59-52.3K	52.3 KΩ	19701	RN55-D-5232F
R63	59-133K	133 KΩ	19701	RN55-D-1333F
R64	59-40.2K	40.2 KΩ	19701	MF5C-D-4022F
R65		NOT ASSIGNED		
R66		NOT ASSIGNED		
R67	59-4.02K	4.02 KΩ	19701	MF5C-D-4021F
R68	59-4.02K	4.02 KΩ	19701	MF5C-D-4021F
R69	59-30.1K	30.1 KΩ	19701	RN55-D-3021F
R70	59-249K	249 KΩ	19701	MF5C-D-2493F
R71		NOT ASSIGNED		
R72	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R73	59-68.1	68.1Ω	19701	RN55-D-68R1F
R74	59-1.00K	1.00 KΩ	19701	MF5C-D-2211F
R75	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R76		NOT ASSIGNED		
R77	59-909	909Ω	19701	RN55-D-9090F
R78	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R79	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R80	151-2034-001	1Ω, ±3%, 5 W, WW	91637	RH5-1Ω-3%
R81	59-909	909Ω	19701	RN55-D-9090F
R82		NOT ASSIGNED		
R83	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R84	44-.27	0.27Ω, ±5%, 1/2 W, WW	75042	BWH-0.27Ω/±5%/1/2
R85	59-1.69K	1.69 KΩ	19701	RN55-D-1691F
R86	59-169	169Ω	19701	MF5C-D-1690F
R87	59-19.1K	19.1 KΩ	19701	MF5C-D-1912F
R88	59-3.83K	3.83 KΩ	19701	RN55-D-3831F

TABLE 4-19. PARTS LIST FOR YIG DRIVER (12.4 GHz-18 GHz) ASSEMBLY, A11 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R89		FACTORY SELECTED		
R90	71-91	Pot., 500Ω, ±10%, 3/4 W	75042	960-290-500Ω
R91	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R92	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R93	71-95	Pot., 2 KΩ, ±10%, 3/4 W	75042	960-290-2K
R94		FACTORY SELECTED		
R95	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R96	59-1.50K	1.50 KΩ	19701	MF5C-D-1501F
R97	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R98	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R99		FACTORY SELECTED		
R100	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R101	59-10.0	10.0Ω	19701	MF5C-D-10R0F
		INTEGRATED CIRCUITS		
U1		NOT ASSIGNED		
U2	84-1	Op. Amp.	18324	LM101A
U3	153-7056-001	Op. Amp.	13919	3500A
U4	84-1	Op. Amp.	18324	LM101A

TABLE 4-20. PARTS LIST FOR VOLTAGE REGULATOR NO. 2 ASSEMBLY, A12

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless otherwsie specified, all capacitors are fixed ceramic.		
C1	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C2		NOT ASSIGNED		
C3	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C4	14-53	2μF, ±20%, 50 V	18489	PMT205H.5A
C5	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C6		NOT ASSIGNED		
C7	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C8	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C9	12-94	1μF, ±20%, 50 V	72982	8131-M050-651-105M
C10		NOT ASSIGNED		
C11	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C12	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
		DIODES		
CR1	154-0018-001	Zener, 6.2 V, ±5%, 0.5 W	IND-STD	1N829A
		INDUCTORS		
L1	156-7005-002	750Ω, ±20%, 50 MHz	02114	VK200 10/3B
L2	156-7005-002	750Ω, ±20%, 50 MHz	02114	VK200 10/3B
		TRANSISTORS		
Q1	153-5005-001	G.P., 100 V, 10 W, B30-130	IND-STD	2N6178
Q2	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q3		NOT ASSIGNED		
Q4		NOT ASSIGNED		
Q5		NOT ASSIGNED		
Q6	153-5006-001	PNP, 100 V, 25 W, B30-130	IND-STD	2N6180
Q7	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/4 W, ±1% metal film.		
R1	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R2	59-100	100Ω	19701	MF5C-D-1000F
R3	44-6.8	6.8Ω, ±5%, 1 W, WW	75042	BWG 6.8Ω
R4		NOT ASSIGNED		
R5		NOT ASSIGNED		
R6		NOT ASSIGNED		

TABLE 4-20. PARTS LIST FOR VOLTAGE REGULATOR NO. 2 ASSEMBLY, A12 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R7	59-976	976Ω	19701	MF5C-D-9760F
R8	71-90	Pot., 200Ω, ±10%, 3/4 W	75042	960-290-200Ω
R9	59-1.47K	1.47 KΩ	19701	RN55-D-1471F
R10		NOT ASSIGNED		
R11	59-523	523Ω	19701	MF5C-D-5230F
R12	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R13	44-6.8	6.8Ω, ±5%, 1 W, WW	75042	BWG 6.8Ω
R14	59-100	100Ω	19701	MF5C-D-1000F
R15	59-1.05K	1.05 KΩ	19701	MF5C-D-1051F
R16		NOT ASSIGNED		
R17		NOT ASSIGNED		
R18		NOT ASSIGNED		
R19		NOT ASSIGNED		
R20	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R21	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R22	71-96	Pot., 100Ω, ±10%, 1 W	73138	79PR100
R23	59-2.00K	2.00 KΩ	19701	MF5C-D-2001F
R24		NOT ASSIGNED		
R25		NOT ASSIGNED		
R26		NOT ASSIGNED		
R27		NOT ASSIGNED		
R28		NOT ASSIGNED		
R29		NOT ASSIGNED		
R30		NOT ASSIGNED		
R31		NOT ASSIGNED		
R32		NOT ASSIGNED		
R33	59-576	576Ω	19701	MF5C-D-5760F
		INTEGRATED CIRCUITS		
U1	153-7056-001	Op. Amp.	13919	3500A
U2	153-7056-001	Op. Amp.	13919	3500A
U3		NOT ASSIGNED		
U4	84-21	Voltage Reg., 5 V, 1 A	07263	UGH7805393

TABLE 4-21. PARTS LIST FOR VOLTAGE REGULATOR NO. 1 ASSEMBLY, A13

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless otherwise specified, all capacitors are fixed ceramic.		
C1	13-97	10μF, ±20%, 50 V, fixed Tant.	92703	T362C106M050AS
C2	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C3	12-47	120 pF, ±10%, 1 KV	72982	831-X5R-121K
C4	12-21	27 pF, ±5%, 1 KV	72982	831-U2M-270K
C5	12-82	0.47μF, ±20%, 100 V	88245	CY30A474M
C6	13-97	10μF, ±20%, 50 V, fixed Tant.	92703	T362C106M050AS
C7	12-47	120 pF, ±10%, 1 KV	72982	831-X5R-121K
C8	12-21	27 pF, ±5%, 1 KV	72982	831-U2M-270K
C9	12-56	0.01μF, ±20%, 25 V	71590	UK25-103
C10		NOT ASSIGNED		
C11	12-21	27 pF, ±5%, 1 KV	72982	831-U2M-270K
C12	12-21	27 pF, ±5%, 1 KV	72982	831-U2M-270K
C13	12-100	10μF, ±20%, 35 V, fixed Tant.	97574	TAG-10/35-20
C14	13-91	33μF, ±20%, 25 V, fixed Tant.	56289	196D336X0025LA3
C15	13-91	33μF, ±20%, 25 V, fixed Tant.	56289	196D336X0025LA3
		DIODES		
CR1	81-275	Zener, 18 V, ±5%, 1 W	IND-STD	1N4746A
CR2	81-205	Zener, 15 V, ±5%, 1 W	IND-STD	1N4744A
CR3	81-286	Zener, 22 V, ±5%, 1 W	12954	1N4748A
CR4	556-166-039	Zener, 6.2 V, ±5%, 0.40 W	IND-STD	1N823A
CR5	81-286	Zener, 22 V, ±5%, 1 W	IND-STD	1N4748A
CR6	81-275	Zener, 18 V, ±5%, 1 W	IND-STD	1N4746A
CR7	81-77	Zener, 5.6 V, ±5%, 1 W	IND-STD	1N4734A
CR8	154-0024-001	Zener, 13 V, ±10%, 1 W	IND-STD	1N4743
CR9	81-205	Zener, 15 V, ±5%, 1 W	IND-STD	1N4744A
CR10	81-301	Zener, 12 V, ±5%, 1 W	IND-STD	1N4742A
		TRANSISTORS		
Q1	81-294	Darlington, PNP, 80 V, 70 W, B700	04713	MJE 1092
Q2	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q3	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q4	81-295	Darlington, NPN, 80 V, 70 W, B750 min.	04713	MJE 1102
Q5	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q6	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906

TABLE 4-21. PARTS LIST FOR VOLTAGE REGULATOR NO. 1 ASSEMBLY, A13 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
Q7	153-5006-001	PNP, 100 V, 25 W, B30-130	IND-STD	2N6180
Q8	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q9	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q10	81-295	Darlington, NPN, 80 V, 70 W, B750 min.	04713	MJE 1102
Q11	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q12	81-294	Darlington, PNP, 80 V, 70 W, B700	04713	MJE 1092
Q13	556-146-988	PNP, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3906
Q14	81-270	NPN, 10 A, 70 V, B20-70 MF	04713	MJE 3005
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/4 W, ±1% metal film.		
R1	59-4.02K	4.02 KΩ	19701	RN55-D-4021F
R2	44-.33	0.33Ω, ±5%, 1/2 W, WW	75042	BWH .33Ω±5%
R3		FACTORY SELECTED		
R4	59-1.69K	1.69 KΩ	19701	RN55-D-1691F
R5	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R6	59-49.9K	49.9 KΩ	19701	MF5C-D-4992F
R7	59-4.02K	4.02 KΩ	19701	RN55-D-4021F
R8	59-3.83K	3.83 KΩ	19701	RN55-D-3831F
R9	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R10	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R11	59-715	715Ω	19701	MF5C-D-7150F
R12	59-1.74K	1.74 KΩ	19701	MF5C-D-1741F
R13	59-2.10K	2.10 KΩ	19701	MF5C-D-2101F
R14	71-90	Pot., 200Ω, ±10%, 3/4 W	19701	960-290-200Ω
R15	59-953	953Ω	19701	MF5C-D-9530F
R16	44-.33	0.33Ω, ±5%, 1/2 W, WW	75042	BWH .33Ω±5%
R17	59-1.69K	1.69 KΩ	19701	RN55-D-1691F
R18	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R19	59-49.9K	49.9 KΩ	19701	MF5C-D-4992F
R20	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R21	59-20.0K	20.0 KΩ	19701	MF5C-D-2002F
R22	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R23	59-4.99K	4.99 KΩ	19701	MF5C-D-4991F
R24	59-4.99K	4.99 KΩ	19701	MF5C-D-4991F

TABLE 4-21. PARTS LIST FOR VOLTAGE REGULATOR NO. 1 ASSEMBLY, A13 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R25	59-4.99K	4.99 KΩ	19701	MF5C-D-4991F
R26	71-91	Pot., 500Ω, ±10%, 3/4 W	75042	960-290-500Ω
R27	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R28	59-2.21K	2.21 KΩ	19701	MF5C-D-2211F
R29	59-6.81K	6.81 KΩ	19701	MF5C-D-6811F
R30	59-1.00K	1.00 KΩ	19701	MF5C-D-6811F
R31	59-10.5K	10.5 KΩ	19701	MF5C-D-1052F
R32	59-604	604Ω	19701	RN55-D-6040F
R33	59-511	511Ω	19701	MF5C-D-5110F
R34	59-100	100Ω	19701	MF5C-D-1000F
R35	44-.39	0.39Ω, ±5%, 1/2 W, WW	75042	BWH-0.39Ω
R36	59-2.37K	2.37 KΩ	19701	RN55-D-2371F
R37	59-5.49K	5.49 KΩ	19701	MF5C-D-5491F
R38	59-4.99K	4.99 KΩ	19701	MF5C-D-4991F
R39	59-931	931Ω	19701	RN55-D-9310F
R40	59-511	511Ω	19701	MF5C-D-5110F
R41	59-100	100Ω	19701	MF5C-D-1000F
R42	44-.39	0.39Ω, ±5%, 1/2 W, WW	75042	BWH-0.39Ω
R43	44-.33	0.33Ω, ±5%, 1/2 W, WW	75042	BWH .33Ω±5%
R44	59-11.0K	11.0 KΩ	19701	MF5C-D-1102F
R45	59-5.36K	5.36 KΩ	19701	MF5C-D-5361F
R46	59-10.5K	10.5 KΩ	19701	MF5C-D-1052F
		INTEGRATED CIRCUITS		
U1	84-1	Op. Amp.	18324	LM101A
U2	84-1	Op. Amp.	18324	LM101A
U3	84-1	Op. Amp.	18324	LM101A
U4	84-1	Op. Amp.	18324	LM101A

TABLE 4-22. PARTS LIST FOR POWER SUPPLY ASSEMBLY, A14

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		FAN		
B1	193-2	Motor, 105/120 V, 50/60 Hz, 18 W	88869	
		CAPACITORS		
		NOTE: Unless otherwise specified, all capacitors are fixed ceramic.		
C1	13-106	5,000μF, +100%-10%, 50 V, fixed Elect.	90201	FAH-5000-50-E2
C2	13-107	10,000μF, +100%-10%, 25 V, fixed Elect.	90201	FAH-10000-25-E2
C3	556-201-100	8,000μF, +100%-10%, 15 V, fixed Elect.	56289	39D808G015JT4
C4	13-81	2,300μF, +100%-10%, 50 V, fixed Elect.	56289	39D238G050JT4
C5	150-5010-009	1,100, +100%-10%, 50 V, fixed Elect.	56289	39D118G050HP4
C6	12-34	0.1μF, +80% -20%, 100 V	72982	845-220-X5V0-104Z
C7	12-34	0.1μF, +80% -20%, 100 V	72982	845-220-X5V0-104Z
C8	12-72	0.1μF, ±20%, 100 V	72982	8131-100-W5R-104M
C9	12-72	0.1μF, ±20%, 100 V	72982	8131-100-W5R-104M
C10	12-72	0.1μF, ±20%, 100 V	72982	8131-100-W5R-104M
C11	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C12	12-2	0.001μF, ±10%, 1 KV	72982	851-X5R-102K
		DIODES		
CR1	81-329	Bridge, 400 V, 4 A	14099	SCRA-4
CR2	81-329	Bridge, 400 V, 4 A	14099	SCRA-4
CR3	81-328	G.P., 3 A, 400 V	14099	3S1-4
CR4	81-328	G.P., 3 A, 400 V	14099	3S1-4
CR5	81-328	G.P., 3 A, 400 V	14099	3S1-4
CR6	81-328	G.P., 3 A, 400 V	14099	3S1-4
CR7	81-328	G.P., 3 A, 400 V	14099	3S1-4
CR8	81-328	G.P., 3 A, 400 V	14099	3S1-4
CR9	81-328	G.P., 3 A, 400 V	14099	3S1-4
CR10	81-328	G.P., 3 A, 400 V	14099	3S1-4
CR11	81-20	G.P., 1 A, 600 V	IND-STD	1N4005
CR12	81-20	G.P., 1 A, 600 V	IND-STD	1N4005
CR13	81-20	G.P., 1 A, 600 V	IND-STD	1N4005
CR14	81-20	G.P., 1 A, 600 V	IND-STD	1N4005

TABLE 4-22. PARTS LIST FOR POWER SUPPLY ASSEMBLY, A14 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
CR15	81-328	G.P., 3 A, 400 V	14099	3S1-4
CR16	81-328	G.P., 3 A, 400 V	14099	3S1-4
		FUSES		
F1	121-26	Slo Blo, 3 A, 125 V	75915	313003
F2	121-1.5	Slo Blo, 1.5 A, 220 V	75915	31201.5
		CONNECTOR		
J1	168-3019-001	Connector, Jack, 7 pin	27264	09-66-1071
		RELAY		
K1	158-0011-001	SPST, 24 V	17738	RU110024
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/2 W, ±1% metal film.		
R1	56-3.32K	3.32 KΩ	19701	MF6C-D-3321F
R2	56-1.50K	1.50 KΩ	19701	MF6C-D-1501F
R3	56-1.00K	1.00 KΩ	19701	MF6C-D-1001F
R4	56-10.0K	10.0 KΩ	19701	MF6C-D-1002F
R5	56-2.21K	2.21 KΩ	19701	MF6C-D-2211F
		TRANSFORMER		
T1		Transformer per SCD	88869	91-226

TABLE 4-23. PARTS LIST FOR MOTHER BOARD ASSEMBLY, A15

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless otherwise specified, all capacitors are fixed Tantalum.		
C1	13-98	220μF, ±20%, 10 V	56289	196P228X001TE4
C2	13-93	250μF, +100% -10%, 25 V	90201	MTV250-ON25
C3	13-89	100μF, ±20%, 20 V	56289	196D107X0020MA3
C4	13-89	100μF, ±20%, 20 V	56289	196D107X0020MA3
C5	13-93	250μF, +100% -10%, 25 V	90201	MTV250-ON25
C6	13-93	250μF, +100% -10%, 25 V	90201	MTV250-ON25
C7	13-98	220μF, ±20%, 10 V	56289	196P228X001TE4
C8	12-100	10μF, ±20%, 35 V	97574	TAG-10/35-20
C9	13-98	220μF, ±20%, 10 V	56289	196P228X001TE4
		CONNECTORS		
XA1	168-3017-001	Dual 36/72 Pin	89110	583660-1
XA2	168-3017-001	Dual 36/72 Pin	89110	583660-1
XA3	168-3017-001	Dual 36/72 Pin	89110	583660-1
XA4	168-3017-001	Dual 36/72 Pin	89110	583660-1
XA5	168-3017-001	Dual 36/72 Pin	89110	583660-1
XA6	168-3017-001	Dual 36/72 Pin	89110	583660-1
XA7	168-3018-001	Dual 28/56 Pin	89110	2-583660-7
XA8	168-3018-001	Dual 28/56 Pin	89110	2-583660-7
XA9	168-3018-001	Dual 28/56 Pin	89110	2-583660-7
XA10	168-3018-001	Dual 28/56 Pin	89110	2-583660-7
XA11	168-3018-001	Dual 28/56 Pin	89110	2-583660-7
XA12	168-3018-001	Dual 28/56 Pin	89110	2-583660-7
XA13	168-3018-001	Dual 28/56 Pin	89110	2-583660-7

TABLE 4-24. PARTS LIST FOR -5 V REGULATOR ASSEMBLY, A16

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless otherwise specified, all capacitors are fixed ceramic.		
C1	12-21	27 pF, ±5%, 1 KV	72982	831-U2M-270K
C2	13-91	33μF, ±20%, 25 V	56289	196D336X0025LA3
C3	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
		DIODES		
CR1	81-301	Zener, 12 V, ±5%, 1 W	IND-STD	1N4742A
CR2	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR3	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR4	81-77	Zener, 5.6 V, ±5%, 1 W	IND-STD	1N4734A
		TRANSISTORS		
Q1	153-5005-001	G.P., 100 V, 10 W, B30-130	IND-STD	2N6178
Q2	153-5006-001	PNP, 100 V, 25 W, B30-130	IND-STD	2N6180
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/4 W, ±1% metal film.		
R1	56-1.21K	1.21 KΩ, 1/2 W	19701	MF6C-D-1211F
R2	59-5.11K	5.11 KΩ	19701	RN55-D-5111F
R3	44-6.8	6.8Ω, ±5%, 2 W, WW	75042	BWH, 6.8Ω±5%
R4	59-3.32K	3.32 KΩ	19701	MF5C-D-3321F
R5	59-10.5K	10.5 KΩ	19701	MF5C-D-1052F
R6	59-4.99K	4.99 KΩ	19701	MF5C-D-4991F
R7	59-1.05K	1.05 KΩ	19701	MF5C-D-1051F
		INTEGRATED CIRCUIT		
U1	84-1	Op. Amp.	18324	LM101A

TABLE 4-25. PARTS LIST FOR SWITCH BOARD ASSEMBLY, A17

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
		CAPACITORS		
		NOTE: Unless otherwise specified, all capacitors are fixed ceramic.		
C1	12-21	27 pF, ±5%, 1 KV	72982	831-U2M-270K
C2	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C3	12-56	0.01μF, ±20%, 25 V	56289	C069B250E103Z
C4		NOT ASSIGNED		
C5	12-21	27 pF, ±5%, 1 KV	72982	831-U2M-270K
C6	12-21	27 pF, ±5%, 1 KV	72982	831-U2M-270K
		DIODES		
CR1	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR2		NOT ASSIGNED		
CR3	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
CR4	154-0013-001	G.P., 10 mA, 75 V	IND-STD	1N4148
		RELAYS		
K1	106-61	SPDT, 24 V	31951	220-001-24
K2		NOT ASSIGNED		
K3	106-61	SPDT, 24 V	31951	220-001-24
		TRANSISTORS		
Q1	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
Q2	556-146-989	NPN, 40 VC Max, 0.31 W, B100-300	IND-STD	2N3904
		RESISTORS		
		NOTE: Unless otherwise specified, all resistors are fixed 1/4 W, ±1% metal film.		
R1	59-1.00K	1.00 KΩ	19701	MF5C-D-1001F
R2	71-93	Pot., 10 KΩ, ±10%, 3/4 W	75042	960-290-10K
R3		NOT ASSIGNED		
R4		NOT ASSIGNED		
R5	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R6	59-100	100Ω	19701	MF5C-D-1000F
R7	59-100	100Ω	19701	MF5C-D-1000F
R8	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R9	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R10	59-10.0K	100Ω	19701	MF5C-D-1000F

TABLE 4-25. PARTS LIST FOR SWITCH BOARD ASSEMBLY, A17 (CONT.)

REF. DESIG.	SINGER PART NO.	DESCRIPTION	MFR. CODE NO.	MFR. PART NO.
R11	59-4.99K	4.99 KΩ	19701	MF5C-D-4991F
R12	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R13	59-10.0K	10.0 KΩ	19701	RN55-D-1002F
R14	59-226K	226 KΩ	19701	RN55-D-2263F
R15	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R16	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
R17	59-4.64K	4.64 KΩ	19701	MF5C-D-4641F
		SWITCH		
S1	161-0038-001	Push Button	31918	4XF12.5STD (None) 20-GR
		INTEGRATED CIRCUITS		
U1	84-1	Op. Amp.	18324	LM101A
U2	84-1	Op. Amp.	18324	LM101A
U3	84-1	Op. Amp.	18324	LM101A

TABLE 4-26. DIAL PLATE PART NUMBERS

FREQUENCY	PART NUMBERS
2-8 and 2-18 GHz	942-407-02
4-12 and 2-18 GHz	942-407-03
8-18 and 12-18 GHz	942-407-04

TABLE 4-27. REPLACEMENT FIELD SERVICE KITS

The 103-XXXX-XXX assemblies listed below are part of overall 102-XXXX-XXX Field Service Kits. When ordering replacement 103-XXXX-XXX assembly that appears in Table 4-27, always order the complete Field Service Kit. This ensures that the matched or pre-adjusted assemblies are installed at the correct time.

102-0225-001	
103-3118-001	A5 Connector P.C.B.
103-3118-00	Add - On Kit
102-0226-001	
103-3124-001	A6 Band Cont. Logic P.C.B.
102-0227-001	
103-3115-001	A8 Yig Driver (.01-4 GHz)
103-2188-004	Yig Oscillator Assembly (S Band)
102-0228-001	
103-3117-001	A9 V.T.O. Driver (4-8 GHz)
103-3117-003	Add - On Kit
103-2190-001	V.T. Oscillator Assembly (C Band)
102-0229-001	
103-3110-001	A10 Yig Driver (8-12.4 GHz)
103-3110-003	Add - On Kit
103-2191-002	Yig Oscillator Assembly (X Band)
102-0230-001	
103-3190-001	All Yig Driver (12.4-18 GHz)
103-3109-003	Add - On Kit
103-2192-002	Yig Oscillator Assembly (Ku Band)